Chapter 3

Sex&Gender&Sexuality

Intersecting Continua

Special Delivery

It's a baby!

Baby Jan

Born: December 31, 1952
6 lbs. 13 ozs. 19"
Helen and Dan Yoder

I happened upon the birth announcement my parents sent out when I was born. It looked a lot like the one above, but one prominent bit of information from the original is missing in my re-creation. The original was adorned with a pink ribbon and announced "It's a girl!" Check out the announcements and congratulatory cards you'll find in almost any store and most, if not all, will highlight the sex of the baby (Bridges, 1993), and they most commonly will express pride in the birth of a son and happiness in the birth of a daughter (Gonzalez & Koestner, 2005). Interestingly, daughters whose mothers more frequently told them the story of their birth exhibited higher self-esteem and stronger attachment to their mother than daughters who heard this story less often (Hayden et al., 2006).

What would parents do if they weren't sure about the sex of their baby? Usually knowing whether it's a girl or a boy is one of the first pieces of information parents get about their newborn. Although we usually take the accuracy of a doctor's immediate pronouncement for granted, how does that doctor know?

Easy answer: genitals. As you may have guessed from the fact that I asked this question, nature is not always this accommodating. We will start this chapter by looking at **intersexuality**, physically falling somewhere between completely biologically female or male. My first point is that even biological sex isn't as clear-cut as we may have thought.

Understanding how fetuses develop into girls and boys leads us to my second point in this chapter about the impact of biology on gender differences. Experiments with animals that would be unethical with humans allow researchers to manipulate biology and then note the impact of these changes on subsequent behavior. However, there are leaps of faith to be made when generalizing from one species of animal to another, yet alone from animals to humans (Weinstein, 1993). When nature deviates from the typical, it gives researchers an opportunity to look for correlational patterns in human biological development and subsequent behavior. We'll explore some of what we know about links between prenatal development and later behavioral expression in girls/women and boys/men that may contribute to group differences. We'll also review some normal biological changes within individuals that predict task performance.

Finally, we'll explore the meaning of biological causes as explanations for gender differences. We'll see that some of our folk wisdom about biology is a far cry from the more sophisticated understandings by biopsychologists themselves. I suspect that you'll come away from this chapter with a very different idea about what it means to be a woman or a man than when you began.

SEX, GENDER, AND INTERSEXUALITY

When medical personnel in the delivery room quickly look at the visible genitals of a newborn in order to declare its sex, they are informed by only part of the complete picture. The **external genitalia** of a clitoris, labia minora and majora, and vaginal orifice (a girl) are typically accompanied by XX **chromosomes**, ovaries (**gonads**), a balance of more estrogens and less androgens (**gonadal hormones**), and fallopian tubes and a uterus (**internal accessory organs**). Similarly, a boy's penis and scrotum are usually packaged with XY chromosomes, testes, more androgens and less estrogens, plus vas deferens and seminal vesicles.

Notice that by announcing the birth of a girl or boy, two assumptions are made. First, there are two, and only two, possibilities: girl *or* boy (**dimorphism**). Second, there is an internally consistent set of five components (external genitalia, chromosomes, gonads, gonadal hormones, and internal accessory organs) that sort into just these two possibilities. However, the interplay among these components is much more complex than this dimorphism suggests. A look at how the external genitals develop will help make this point clearer.

Typical Reproductive Development

Eventual female and male fetuses start out with similar sex organs (the gonadal ridges, internal ducts, and external genitalia) (see Figure 3.1). At 6 to 7 weeks gestation, every fetus has the potential (called a **bipotential**) to develop its **indifferent gonad** into either a female or male configuration.

This is where the chromosomes come in, determining whether the gonadal ridge develops into either an ovary (female) or a testis (male). If a Y chromosome is present, the tissue of the indifferent gonad organizes into an embryonic testis. This testis then synthesizes one hormone to block female development and a second set of hormones (**androgens**) to masculinize the external genitalia. The genital tubercle grows into the penis, and the genital swellings fuse to form a scrotum.

Without the Y chromosome, the ultimately female embryo develops ovaries. In a less well-understood process, the genital tubercle becoming the clitoris; the genital swellings, the labia majora; and the genital folds, the labia minora. The key points for our upcoming discussion are that a fetus has the potential to develop either way and that **chromosomes** and **hormones** play central roles during a limited critical period in fetal development toward channeling that development along feminized or masculinized paths.

Intersexed Development

Each of the five categories of reproductive parts (chromosomes, gonads, gonadal hormones, internal reproductive structures, and external genitalia) may better be thought of as a continuum, not as a discrete category that represents an either-or, all-or-nothing duality.[1] *Healthy* children are born with all sorts of combinations and variations of these parts. The old term for these people was "hermaphrodites," capturing the idea that these people are

[1]The following discussion of intersexuality draws on four main sources: the Johns Hopkins Children's Center website (*http://www.hopkinschildrens.org/intersex/*); Anne Fausto-Sterling's (2000) book, *Sexing the Body*; Suzanne Kessler's (1998) book, *Lessons from the Intersexed*; and Rebecca Jordan-Young's (2010) book, *Brain Storm: The Flaws in the Science of Sex Differences.*

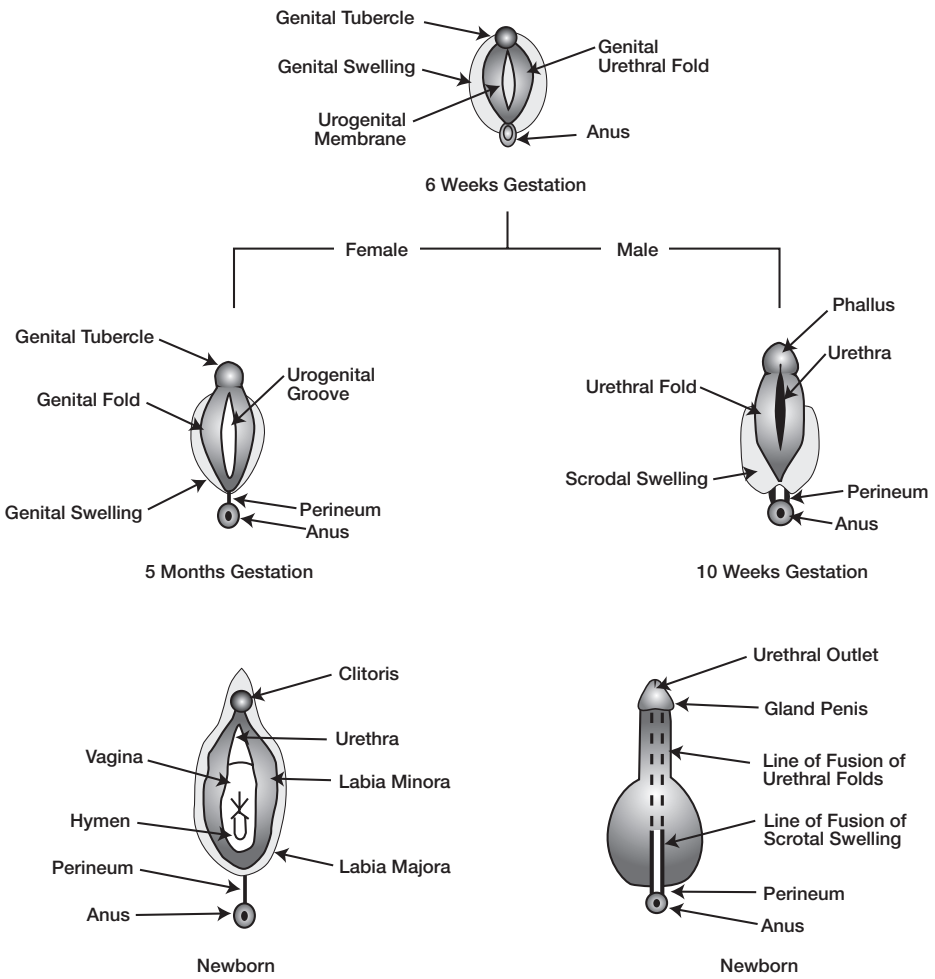

Figure 3.1
Typical sex differentiation. Development of female and male external genitalia begins with the indifferent gonad but takes a different route after 6 weeks gestation depending on the chromosomes present.

blends of female and male. However, this terminology retains the notion that there is a discrete combination that is female and another that is male, with hermaphrodites simply being parts of each (or both). A better approach is to think of continua whereby each and every one of us falls somewhere between two extreme possibilities for each of the five parts. Some of us define all the endpoints; others fall somewhere in between. To capture this conceptualization, more modern terminology has moved to **intersexed**.

Wait, you may insist. These are rare conditions, hardly meriting mention let alone such an extended discussion. You may be surprised by the scholarly estimates. No one knows an exact figure, but a reasonable ballpark is 1.7% of all live births, many of which are not obviously detectable (Fausto-Sterling, 2000, p. 51). If this still seems miniscule, consider this: at this rate, a medium-sized city of 300,000 people would likely have 5,100 people with

some form of intersexed development. Being intersexed is not spread uniformly around the world; there are pockets where genetic contributions to some forms of intersexuality make them more prevalent.

Chromosomes, gonads, and hormones. Let's play out this idea of continua of sexual development more concretely starting with sex **chromosomes**. There are an array of variations in chromosomes other than XX and XY, with the most common being Turner and Klinefelter Syndromes. Females with **Turner Syndrome** are missing a second X chromosome (XO); their ovaries do not develop, their stature is short, and they lack secondary sex characteristics. Treatment usually involves estrogen and growth hormones. Males with **Klinefelter Syndrome** receive an extra X chromosome (XXY) causing breast enlargement at puberty and infertility. Treatment typically includes **testosterone** therapy.

The middle ground for the gonads (ovaries and testes) includes all sorts of combinations involving both functional and nonfunctional ovary(ies) and testis(es) as well as fully functional pairs of each (called ovo-testes). As for the gonadal hormones, we *all* have some concentrations of **estrogens** and **androgens** in our bodies. Estrogen is secreted by the ovaries, which also produce progesterone so that we misleadingly think of estrogen as a "female" hormone. Androgens are the general name for the "male" sex hormones secreted by the testes, which include several types of testosterone.

The tendency to label these hormones as "female" and "male" ignores the fact that the adrenal cortex produces androgens in women (as do the ovaries in small amounts) and estrogens in men (as do the testes in small amounts) (Becker & Breedlove, 1992). All are involved in tissue growth beyond the reproductive system, so discussing them primarily within the framework of sexuality belies their true general growth function. We would be better served to think of these hormones as general *growth hormones* (Fausto-Sterling, 2000, p. 28). Androgens can even be converted to estrogens in a woman's body, further blurring this distinction between these two types of hormones.

What does differentiate women and men, girls and boys, is the *concentrations* of each of these hormones. But even this blurs at times. Across prenatal development, XY fetuses have higher levels of testosterone than XX fetuses between 8 to 24 weeks gestation; then after that, gondadal hormone levels are low in both sexes (Hines, 2004a). Even during the prenatal period of peak difference, an examination of the amniotic fluid surrounding the embryo reveals that 25% of the males and 9% of the females had overlapping levels of testosterone (Finegan et al., 1989). A second surge in testosterone occurs in boys from their first to sixth month of infancy (Hines, 2004a); however, only at puberty is there no overlap between girls' and boys' testosterone levels (Hoyenga & Hoyenga, 1993). In sum, both women and men possess both estrogen and testosterone; women generally have more of the former and men more of the latter. Again, a continuum better characterizes them than the dimorphism with which we began.

Genitals: Size matters. We all probably think we know the difference between a clitoris and a penis, but they really are just socially constructed designations for different ranges along a continuum measuring the size of the *same tissue*. Of all the possible ways to assign gender to a baby, phallus size seems to take primacy in today's medical community. (Interestingly, gonads were primary in the 19th century.)

The medical community has established size standards for identifying clitorises and penises (see Figure 3.2). These are based more on psychological adequacy or appear-

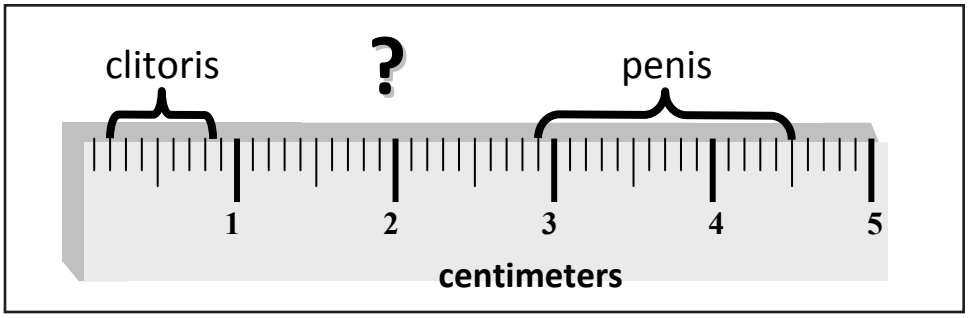

Figure 3.2
Phallus size matters. Although nature typically groups the same genital tissue into two clusters between 0.2 to .85 (a clitoris) and 2.9 to 4.5 (a penis) centimeters, a few ambiguous phalluses fall in between. Did nature make a mistake or is that what nature intended? Is tissue measuring 2.0 centimeters an enlarged clitoris or a "micropenis"? Interestingly, undergraduates estimate newborns' clitorises as bigger than they typically are (.9 to 1.9 centimeters) and newborn penises as smaller (2.1 to 3.6 cm) (Kessler, 1998, p. 100). In addition to phallus size, genitals can be ambiguous because they include a structure that resembles partially fused labia or a split scrotum, or the urethral (urinary) opening may not be at the tip of the penis.

ance than on physical health or utility. A clitoris needs to be ascetically acceptable to a future sexual partner (not too big). A penis needs to do three things: allow its holder to urinate standing, measure up to public scrutiny, and in its adult form, penetrate a vagina. To accomplish the first task, it needs to have its urethral opening at the tip. A study of 500 men hospitalized for an aliment other than **hypospadius** found that only 55% fit the standard for "normality"; most of the deviations were mild, unknown, and accommodated by their holders (cited in Fausto-Sterling, 2000, p. 57). As for sexual utility, phallus size at birth appears unrelated to size and function at puberty (Fausto-Sterling, 2000, p. 58).

Genitals and intersexuality. *Intersex* babies come with one of three natural configurations of external genitalia: female, ambiguous, or male but with a small "micropenis," making phallus size an inadequate indicator of intersexuality. For example, XY ("male") intersex babies can have genitals that look female. In these cases, the genital tubercle developed into a clitoris, the genital swellings into the labia majora, and the genital folds into the labia minora. These babies are likely to be assigned as girls at birth despite their genetic "maleness."

XY ("male") babies also can have "under-masculinized" ambiguous genitals if they are exposed to less-than-normal amounts of androgens. For example, when there is a genetically inherited change in the fetus's receptor cells for testosterone, called **Complete Androgen Insensitivity Syndrome** (CAIS), cells cannot capture and use testosterone to shape development in a masculine direction. Given this under-masculinization of the baby's genitals, CAIS babies are raised as girls, often without any awareness that something is unusual. This syndrome is usually first detected at puberty when adolescents with CAIS develop breasts and a feminine body shape but fail to menstruate. Interestingly, it is rare for people with either complete or partial AIS to initiate sex re-assignment and to express serious discontent with their initially assigned sex (Mazur, 2005). This syndrome is relatively rare, estimated to occur in 1 to 5 of every 100,000 live births (Cohen-Bendahan et al., 2005).

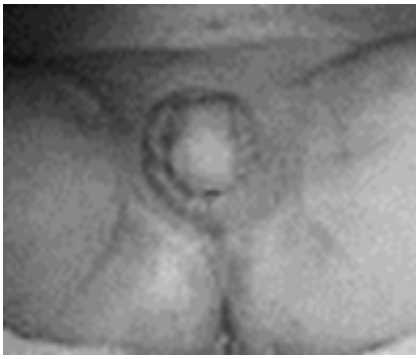

Figure 3.3
A CAH infant with XX chromosomes and fully masculinized external genitalia.

XX ("female") babies can be exposed prenatally to greater-than-normal amounts of androgens (produced by their own adrenal glands) causing their developing genitals to masculinize, even though their internal reproductive organs are those of a potentially fertile woman. These babies are diagnosed with **Congenital Adrenal Hyperplasia** (CAH). Their genitals can appear fully masculine (see Figure 3.3) or ambiguous, and they commonly are raised as girls, although some are designated as boys. The incidence of CAH is estimated at about 1 in 14,000 live births (Hines, 2004a, p. 16).

When a newborn's phallus is ambiguous, sex assignment is typically determined by a team of physicians who move quickly, often citing parents' impatience, to decipher nature's "intention" and fix the "mistake." Given that technology in reconstructive/ cosmetic surgery is more advanced for feminizing than masculinizing ambiguous phalluses, various degrees of clitoral reduction or elimination often are attempted, setting the child up for likely future operations, hormone therapies, etc. Both Suzanne Kessler (1998) and Anne Fausto-Sterling (2000) decry the lack of empirical support for the efficacy of surgical intervention, and Kessler especially documents the pain and scarring that often accompany these multiple interventions.

Some people who are intersexed are becoming more militant about medical approaches to children with ambiguous genitals. For example, the Intersex Society of North America "is devoted to systemic change to end shame, secrecy, and unwanted genital surgeries for people born with an anatomy that someone decided is not standard for male or female" (ISNA, 2011). This organization recommends a model of care that is patient-centered, rather than surgery-centered.

BIOLOGICAL BASES FOR DIFFERENCE

Our rather detailed overview of reproductive development leads to two important conclusions. First, even biology does not cleanly sort women and men into two groups. Second, although we talk about feminizing and masculinizing development as though they are endpoints on the same one continuum, they really exist as multiple continua that are sometimes separate (estrogens/androgens) and other times, the same (clitoris/penis).

The above discussion also lays the groundwork for us to explore biology as an explanation for some of the gender differences we saw in Chapter 2. As we have seen, a fetus's

reproductive structures develop in response to both chromosomes and hormones. These typically sort us into female or male categories, which are formalized at birth, usually based on genitals, with our sex assignment (see Figure 3.4). From birth on, environment comes into play so that ongoing behaviors throughout childhood and adulthood reflect an interchange between nature (biology) and nurture (environment).

A relatively new and fascinating area of study draws on a **neuroendrocrine approach** by examining the relationship between reproductive hormones in the brain and gender differences in human behavior (Hampson & Moffat, 2004). There are two major strands of research in this area of **brain organization research**, with the first looking at how prenatal exposure to hormones during *fetal* brain development may affect later behavior (**organizational effects**), and the second focusing on concentrations of hormones and their impact on specific activities of the *adult* brain (**activational effects**). In contrast to organizational effects, which are relatively permanent, activational effects can come and go within the same individual.

As you can see in Figure 3.4, the causal pathways considered by a neuroendrocrine approach are complex. Hormones, both prenatally and throughout life, are expected to affect human brains and work with them to impact behavior. We'll start by looking at research that connects both prenatal and ongoing hormones to childhood and adult behavior, specifically behaviors that distinguish girls/women and boys/men as groups. Because organizational effects presumably shape female and male brains prenatally, we'll then look at evidence for the existence of different female and male brains.

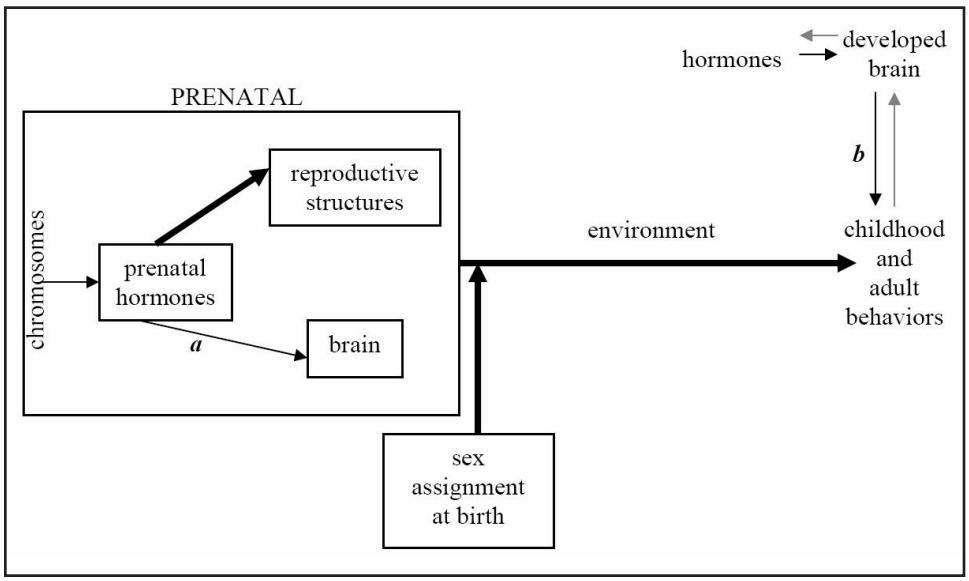

Figure 3.4

A general schematic of a neuroendrocrine approach, which predicts organizational and activational effects of hormones on the prenatal and developed brain, respectively, and ultimately on childhood and adult behaviors. A time line representing individual development runs from left to right, with boxed entries representing discrete events and open items ongoing events across the life course.

[a]Organizational effects
[b]Activational effects

HORMONES

We have seen that the reproductive hormones, estrogen and the androgens including testosterone, play a major role in how human reproductive structures, like the clitoris and penis, develop. Nature provides researchers with a **naturalistic study** of the impact of hormones with the birth of CAH (**Congenital Adrenal Hyperplasia**) and CAIS (**Complete Androgen Insensitivity Syndrome**) babies. Keep in mind though that these studies are necessarily not true experiments; rather, they either compare people with and without CAH and/or CAIS (quasi-experiments) or rely on retrospective accounts (Jordan-Young, 2010).

Because CAH babies, with XX chromosomes, were exposed to an unusually large amount of androgens prenatally, their external genitals are masculinized to various degrees. If their external genitals are ambiguous, they usually undergo genetic testing and, based on their chromosomes, are reared as girls—often after surgically feminizing their genitals and being treated with hormones (Hines, 2004b). A small subset of CAH babies go undetected because their genitals fit the standards for a penis, and thus begin life as boys. Oftentimes these boys are reassigned to be girls when other signs of CAH are noticed early in their childhood. However, a few CAH children continue as boys, providing researchers with a convenient, albeit small, comparison sample of CAH children for whom sex assignment is male. In contrast, because CAIS typically is not detected until puberty, these chromosomal XY babies who did not respond to their prenatal exposure to androgens commonly are reared as girls and remain so (Mazur, 2005).

These trends give researchers three groups with unusual hormonal backgrounds to study: (1) CAH girls with high androgen exposure, (2) CAH boys with XX chromosomes and high androgen exposure, and (3) CAIS girls who were unaffected by the androgens to which they were exposed (see Table 3.5). If androgen (which typically affects male development) is involved in differences between women and men, we would expect CAH girls to behave more like unaffected[2] boys than unaffected girls and CAIS insensitive girls to be more like unaffected girls than unaffected boys (see Figure 3.6). If CAH boys behave more like unaffected boys, this too would be consistent with an explanation involving hormones (because both share androgen exposure and utilization) and that trumps genes (because they have XX and XY chromosomes, respectively). *Thus what we learn about hormones comes from consistent patterns of comparisons.*

To control to some degree for socialization experiences, the unaffected siblings of these children without these syndromes become good comparisons. However, like all naturalistic studies, our findings remain correlational with lots of possible alternative explanations (Cohen-Bendahan et al., 2005). For example, the parents of CAH girls know that their daughters were born with a more penis-like clitoris, and the girls themselves often come to know about their histories. This could impact how they are treated and think about themselves (Bem, 1993; Jordan-Young, 2010). Although parents generally report that they treat their CAH daughter like any other girl (Berenbaum & Hines, 1992), they are often told to expect tomboyism and impaired fertility—raising the possibility that their expectations set up a developmental context that is unique to CAH girls (Jordan-Young, 2010).

[2]Notice the care I took in NOT using the term "normal." Clearly unaffected girls and boys are statistically *normative* because most humans develop as either XX girls not exposed to masculinizing androgens prenatally or XY boys exposed to and sensitive to this wash of androgens in the womb. "Normal" though also can connote *natural*, and both CAH and CAIS children are born naturally without intervention. How we think and talk about these issues can affect how we feel about medical interventions to change atypical genitals as well as sex assignment.

TABLE 3.5
The Relationships Among Chromosomes, Prenatal Androgens, Sex Assignment, and Phallus Development

Chromosomes	Androgen Exposure or Sensitivity: High	Androgen Exposure or Sensitivity: Low/None
XX	CAH girls CAH boys --- ambiguous phallus or penis	unaffected girls --- clitoris
XY	unaffected boys --- penis	CAIS girls --- ambiguous phallus or clitoris

Note: The designation as girl or boy reflects the assigned sex, usually determined by phallus size and its label.

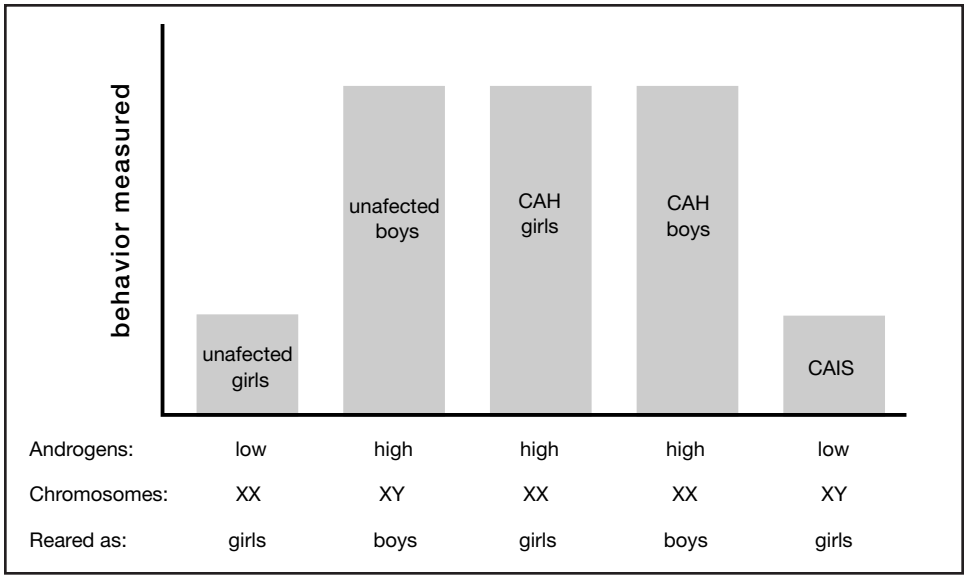

Figure. 3.6
The pattern of comparisons we'd expect in order to show that hormones affect the behavior being measured. The behavior selected to measure originally must show a significant difference between unaffected girls and boys (the two left bars). Think about what these patterns would need to look like to suggest that chromosomes or rearing are largely responsible for the difference between unaffected girls and boys.

Much of this work on the *organizational effects* of prenatal hormones so far has concentrated on explaining known gender differences in childhood play behavior, core gender identity, sexual orientation, social variables (e.g., aggression and nurturing), and cognitive abilities (Hines, 2004a, 2004b; Jordan-Young, 2010). The one area where extensive work on the *activational effects* of adult hormones has been studied is with cognitive skills. We'll explore each of these in turn.

Childhood Behaviors

Earlier studies had linked CAH girls with elevated levels of tomboyism, yet other research showed that describing one's self as a tomboy in childhood is common among women, rising to almost 80% in **cohorts** of women under 25 years-old (Morgan, 1998). The addition of comparison groups in more recent studies with CAH children, although still necessarily correlational, makes patterns of findings with CAH children more compelling (reported in Hines, 2004a), although far from conclusive (Jordan-Young, 2010).

Looking at childhood play (Hines, 2004a), CAH girls across various countries reported increased preferences for male-typed toys (trucks) and reduced interests in female-typed toys (dolls). Observers confirm these toy preferences, and they hold up in contrast to unaffected sisters who made more traditional toy choices. Playmate preferences for CAH girls ran about 50:50 for girl and boy peers, in contrast to their unaffected relatives who, like children in general, favored playmates of their own sex, typically 80 to 90% of the time.

On a more global measure of preschool activities, which catalogues a wide range of activities in 2 to 7 year-olds from wearing gender-typed clothing and rough-and-tumble play, CAH girls as a group showed more male-typical behavior than unaffected girls (Hines, 2004b). However, CAH girls' behaviors fell short of those of unaffected boys so that they scored in the middle between typical girls and boys. CAH boys did not differ from unaffected boys.

Furthermore, although we know that the linkage between human and animal data is tenuous, the findings above do fit with some evidence from animal research. For example, female rhesus monkeys purposively exposed to androgens prenatally engaged in higher levels of rough-and-tumble play than control monkeys (reported in Hines, 2004b, p. 112). These findings are consistent with a model hypothesizing that prenatal hormones permanently affect the developing human brain (have organizational effects). Yet these effects overall are relatively small, represent a narrow subset of all behaviors that could be studied, and cannot be disentangled from the developmental context in which they occur (Jordan-Young, 2010).

Core Gender Identity

Core gender identity (in which girls and women regard their fundamental self as female; boys and men, male) is probably one of the largest psychological gender differences (Collaer & Hines, 1995). Very few people report dissatisfaction with their sex assignment, and even fewer are diagnosed with **gender identity disorder** (GID),[3] which includes persistent discomfort with one's assigned sex and its gender role as well as by desires to be the other sex. There is no solid evidence to link GID with genetic or hormonal abnormalities (Hines, 2004a). However, flipping the way we look at core gender identity, there is some evidence that GID is more common in CAH girls than would be expected by the scarcity of both CAH and GID in the general population. Furthermore, some CAH girls, despite their XX chromosomes, are somewhat less satisfied with their sex assignment than control women. Interestingly, XY CAIS adults without ovaries and reared as women appear just as content to be women as women in general. Obviously, there's a lot of complexity here.

[3]Using population estimates from other sources, Collaer & Hines (1995, p. 62) report incidences of GID for only one in every 50,000 to 100,000 genetic females and one in 20,000 to 30,000 genetic males.

These waters are muddied even further by another form of intersexuality in which enzyme deficiencies cause genitalia to be ambiguous or feminine at birth, yet at puberty the body masculinizes (with male patterns of hair, genitals, and muscle development). These European and North American children typically have their gonads removed so that they remain as girls, in contrast to other cultures where genital variability is part of their conceptualizations of femininity and masculinity (see Fausto-Sterling, 1993). Indeed, there are cultures where more than two sexes are considered normal (Imperato-McGinley et al., 1979; Herdt & Davidson, 1988) so that core gender identity can be much more fluid. What seems to be most clear from these patterns is that the context in which these children are raised matters (Jordan-Young, 2010).

Sexual Orientation

There is some evidence to support the possibility that prenatal hormones may affect, but not totally determine, sexual orientation. CAH women are more likely to be lesbian or bisexual than their unaffected relatives and perhaps exhibit some reduced sexual interest (Hines, 2004a). However, remember that many of these women experienced multiple genital surgeries that may not have been completely satisfactory so that these experiences may contribute to the dissatisfaction these women report (Karkazis, 2008).

There is another group of women whose experiences shed further light on organizational effects regarding sexual orientation. From 1947 until 1971, a half to four million American pregnant women were given a synthetic estrogen, **diethylstilbestrol** (DES), in hopes of preventing miscarriage (Collaer & Hines, 1995). Although later shown to be ineffective, these DES-exposed girls and boys become part of our story here because DES has been shown to masculinize brain development and behaviors of animals without masculinizing their genitals. Thus DES girls parallel CAH girls in that both have XX chromosomes and were exposed prenatally to masculinizing hormones. Melissa Hines (2004a) described three samples across which 40% of 90 DES-exposed women were bisexual or lesbian, compared to only 5% of their unexposed sisters. These findings are consistent with those for CAH women without the alternative possibilities introduced by masculinized genitals and surgeries.

CAIS women are as likely as other women to pursue sexual relationships with men and to marry (Hines, 2004a). If you think about it, this raises some provocative questions about the relationship between biological sex and sexuality. Genetically, CAIS women are XY, making their relationships with men homosexual. However, according to both sex assignment and hormone sensitivity, these women are heterosexual. The conceptually distinct line between sex and sexuality starts to blur here, raising fascinating questions about our definition of sexual orientation. Maybe checking a box on a survey indicating either lesbian/gay or heterosexual is just as ambiguous as we have discovered checking either female or male can be.

Social Variables

As we saw in Chapter 2, although a huge number of social variables exist on which no gender differences have been found or have not been thoroughly studied, quite a few gender differences have been rather clearly established. One of these is aggression, which in

popular lure is associated with **testosterone** (an androgen). However, the linkage between prenatal exposure to androgens and later aggressive behavior is inconsistent. On the one hand, there is no evidence of more fighting by CAH girls compared to female controls. On the other hand, CAH girls scored higher than unaffected female relatives on an aggression subscale of a paper-and-pencil inventory (Hines, 2004b, p. 138-9), possibly highlighting the impact of self-expectancies.

Melissa Hines (2004a) reviews several studies with CAH girls that suggest that nurturing interests, such as in babysitting and having children of one's own, are lower in CAH girls than in their unaffected female relatives, yet again this outcome could be influenced by these girls' expected infertility (Jordan-Young, 2010). The one study completed to date with CAIS girls found no differences between them and female controls. Showing the opposite pattern than CAS girls, CAH boys (with XX chromosomes) reported *more* nurturing than unaffected boys. The first two of these findings suggest that hormones may have organizational effects on later nurturing, and the last finding begins to implicate genes, although (as always) intertwined with context.

Cognitive Abilities

Organizational effects. Early research on prenatal exposure to androgens suggested a link between androgens and IQ, but later analyses showed that this correlation was really the result of **selection bias**. People who received hormone treatments and others who became involved in research studies tended to come from more educated backgrounds (Collaer & Hines, 1995). This is a good example of how we can be less skeptical about, and thus fooled by, data that fit with our expectations.

Better controlled research on the organizational effects of hormones and specific cognitive abilities (verbal, math, and spatial skills) finds little consistent evidence of a clear relationship (Hines, 2004a). For example, there are studies that show enhanced, equal, and impaired spatial abilities among CAH women. Studies of math abilities among both women and men diagnosed as CAH suggest *reduced* skills, rather than the elevated ones general male superiority in math would predict. However, cognitive abilities do appear to show some *activational effects* associated with adult hormones. Read on…

Activational effects: Estrogen. Again, nature sets up some interesting comparisons for researchers, involving both young and midlife women (generally with higher concentrations of estrogen than men) and young and midlife men (generally with higher concentrations of androgens than women). Starting with adult women, estrogen levels vary across young women's menstrual cycles then decline and stabilize with menopause. During **menses** (when a woman is menstruating), the amount of estrogen secreted into her bloodstream (**estradiol**) is low, not differing much from postmenopausal women. In menstruating women, estradiol levels peak by 5 to 12 times during the three days preceding **ovulation** (when the woman releases the egg from her ovary) and in the second half of her menstrual cycle after ovulation occurs. As techniques for pinpointing where women are in their cycle grew more accurate, researchers were able to compare women's performance on cognitive tests at higher and lower estrogen periods. The idea is to look for changes in scores from the same individual and see if these changes map onto her pattern of fluctuations in estrogen levels across her menstrual cycle.

In addition to the natural cycles of changing estrogen levels that women experience, there are three groups for whom estrogen levels have been manipulated deliberately. The first involves women taking oral contraceptives, which themselves vary in their levels of estrogen (and progestrin); the second capitalizes on the use of high doses of ethinyl estradiol to induce the development of secondary sex characteristics in transsexual men; and the third includes hormone replacement therapy for postmenopausal women as well as women whose ovaries were removed surgically (Hampson & Moffat, 2004). A lot of uncertainty is reduced if findings triangulate across both naturally occurring and manipulated (but obviously select) samples.

Such **triangulation** is possible with a relatively large number of studies using spatial tasks on which men outscore women with moderate to large effect sizes. The general pattern is consistent with predictions that elevated estrogens are related to disrupted performance (reviewed by Hampson & Moffat, 2004). Individual women's performance was better on spatial tests during the lowest estrogen phases of their menstrual cycles and worsened when estrogen levels rose.[4] As a group, women on the higher dosage oral contraceptives performed worst on spatial tasks, and estrogen use by a small group of transsexual men was associated with declines in their scores on a mental rotation task.

The corollary of *disruptive* effects of estrogen on tasks on which men in general show superiority is *facilitative* effects of estrogen on tasks on which women typically show an advantage. Although less studied than the deficient findings reported above (androcentric bias?), there is some convergent evidence that estrogen is related to better performance on some verbal tasks. Verbal fluency (word production) was improved at higher estrogen levels for healthy young women, and estrogen use by transsexual men was linked to improvement of their verbal fluency.

In older women, much of researchers' focus on cognitive abilities has concentrated specifically on memory. As Diane Halpern (2000, p. 92-3) points out, memory is a complex skill with no one way to measure it globally. Memories can be **episodic** (about one's own life) or **semantic** (involving facts, historical events not experienced personally, and word knowledge). They can involve grocery lists, name-face associations, short-term memories only 1 to 2 minutes old, etc. Although no one simple test of memory exists, there is a pattern across some studies to suggest that women's memories are better than men's.

This female advantage may be related to estrogen levels. In a series of studies (reported by Hampson and Moffat, 2004), women's memories for factual details of short stories and word pairs were tested both before and after removal of their ovaries (which results in immediate menopause brought on by estrogen reduction). Insuring that both the experimenters and the women themselves did not know which condition they were in, half the women received estrogen immediately after surgery and the other half did not. Women who received immediate estrogen saw no changes in their performance on memory tasks in contrast to the untreated women (taking a **placebo**) whose scores fell after surgery. Taking this study to its next step, the untreated women's sugar pills were replaced with real estrogen pills, and their memory scores improved.

Subsequent studies extended these findings to memory tasks involving nonverbal materials (geometric designs) and to women who completed menopause naturally. Additional research comparing matched sets of postmenopausal women taking and not taking estro-

[4]As a control, these women's performance remained stable across their menstrual cycle on other tasks for which no gender differences exist.

gen replacement found that women *not* taking estrogen committed fully 40% more errors than the other women on verbal and spatial tests of working memory. Younger women scored worse on this same measure of working memory when they were in the phase of their menstrual cycle where estrogen levels were low.

Activation effects: Testosterone. Although we are accustomed to hearing about estrogen changes in women, we seem to hear less about daily, seasonal, and age-related changes in testosterone levels in men and to forget that women have variable levels of testosterone themselves. For both women and men, testosterone levels peak in the early morning then bottom out 12 hours later (see Figure 3.7) (Hampson & Moffat, 2004). For men, testosterone concentrations are higher in autumn than spring (possibly to make births more likely in the spring). From ages 30 to 80, men's testosterone declines by as much as 50%, suggesting *male andropause*. Testosterone levels even vary by culture (possibly reflecting both dietary and lifestyle differences), such that these levels are notably high in men living in Western, industrialized countries.

Again, these naturally occurring variations set up predictions about patterns relating hormones to performance on some cognitive tasks. On both spatial and math (but not verbal) tasks, *moderate* levels of testosterone appear to promote best performance. Looking at groups of men and women, men with lower (more moderate) testosterone levels scored better than men high in testosterone, and women with higher (more moderate) testosterone concentrations outperformed women with lower levels.

Turning to changes across the day within individuals, men's repeated spatial performance peaked later in the day when their testosterone levels were lower (more moderate) in contrast to women, whose scores were best in the early morning when their testosterone levels were highest (more moderate). This pattern is diagrammed in Figure 3.7. Exploring seasonal changes, men's spatial performances were strongest in the spring when their testosterone concentrations were lower (more moderate). Finally, transsexual women who were treated with androgens in the course of becoming male showed increases in their spatial abilities.

At older ages, interest in cognitive abilities again shifts to memory. In a 10-year **longitudinal study** of men aged 50 to 91, higher testosterone levels were associated with higher scores on visual and verbal memory tasks and with less decline in visual memory with

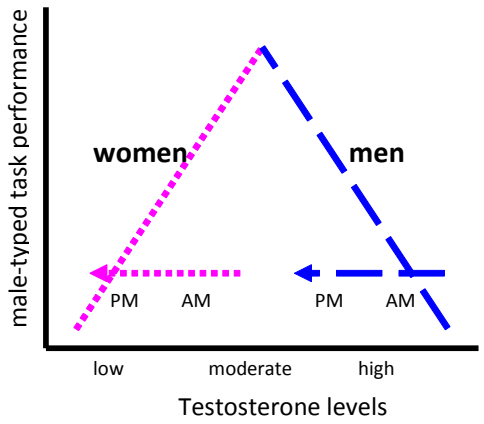

Figure 3.7

Individual women's and men's testosterone levels fall through the day, so that they typically perform best at moderate testosterone levels; that is, morning for women and later in the day for men.

age. Comparisons of older men taking testosterone supplements with men taking **placebos** showed fewer errors in working memory, improved verbal memory, and better recall of traveled routes in treated men.

Section Summary

Across all the studies we have examined here, a consistent pattern emerges that does suggest that reproductive hormones have an impact (Hines, 2010). These patterns appear both across some studies exploring prenatal hormone exposure yielding permanent organizational predispositions, as well as across some studies with adults whose concentrations of both female-associated (estrogens) and male-associated (androgens including testosterone) hormones are related to cognitive performance. The clearest conclusion is that brain organization research is likely to continue.

However, we must continually put these findings in context, including what isn't found (given the vast array of possible outcomes that could be studied), the environment in which these necessarily "post-natal" studies take place; the limitations of not being able to randomly assign people to experimental manipulations, as well as of extrapolating from animals to humans; and methodological inconsistencies (Jordan-Young, 2010). For example, Rebecca Jordan-Young (2010, p. 214) identifies "five main research models where there are data bearing on early hormone exposures and sex-typed interests." Ideally, evidence from each method would converge; however, Jordan-Young concludes that "there is no specific kind of sex-typed interest that is consistently linked to prenatal hormone exposures by more than one research model" (p. 228). Additionally, if hormones are used to explain differences between the sexes, researchers also need to more routinely demonstrate how they affect variations within the sexes (as we have seen with some cognitive differences).

Thus my goal in lending such extensive coverage to brain organization research is not so much about the specific findings about hormones, but rather about giving you the background to read this complex literature and to ask critical questions along the way. Indeed, this last point extends to the notion of "sexed" brains, which, like our reproductive structures, are affected as they develop by chromosomes and hormones. (Take another look at Figure 3.4 here.) So, let's now move from hormones to brains.

SEXED BRAINS

We already have seen that something as clearly "sexed" as our reproductive structures isn't dimorphic. Thus it should be equally clear that something as complex and still unknown as the brain should *not* be dimorphic (Bishop & Wahlsten, 1997). Rather, women's and men's brains are more similar than they are different, exhibiting no gross structural differences (Halpern, 2000, p. 194). Although the brain is involved in sexual behavior and clearly sex-typed functions, like menstruation, there is no reason to generalize without some skepticism from these functions to others, like the cognitive abilities and social variables that make up much of our list of declared gender differences.

Research in this area is still in its infancy, yet hints about subtle sex differences in human brains are intriguing. Researchers seeking brain differences have focused on size, structures, and functionality.

Brain Size

The most enduring pseudo-claim about brain size is that bigger brains signal higher intelligence favoring men (Lynn, 1994). Diane Halpern (2000, p. 196) lays this bogus claim to rest by seriously pointing to no evidence of gender differences in overall intelligence and by humorously pointing out that there's no relationship between hat size and intelligence within sexes. In fact, she cites evolutionary evidence that brains have been shrinking over the past 25,000 years, yet one would be hard pressed to make the case that our currently smaller brains are less intelligent!

Brain Structures and Functions

Three brain structures have captured much of the attention of researchers in this area. The hippocampus and the hypothalamus became likely suspects because each is linked to reproductive hormones. Interest in the **corpus callosum** followed a more circuitous route.

Hippocampus. The **hippocampus** is involved in estrogen feedback loops in adult women and is affected by concentrations of testosterone (reported in Halpern, 2000, pp.197-198). Although animal studies point to associations between sex differences and the hippocampus, studies with humans are rare. However, one provocative study found that after surgical removal of the right hippocampus, women, but not men, experienced declines in their visual-spatial memory.

The hypothalamus, genes, gender, and sexuality. The **hypothalamus** becomes a likely suspect in our search for gender differences in the brain because it plays a role in regulating the amounts of hormones, including the reproductive hormones, circulating in our bodies. In women, estrogen from the ovaries activates the hypothalamus, which stimulates the pituitary gland to release a LH-surge (luteinizing hormone), triggering ovulation. In contrast to this LH-surge, men's hypothalamus produces a steady flow of LH (necessary for sperm formation). The involvement of the hypothalamus in reproductive activities is clear and different for women and men.[5]

One area of the hypothalamus (INAH-3) can be about 2.5 times larger in volume for male than female humans (Allen et al., 1989). However, Anne Fausto-Sterling (1992) points out that there is a ten-fold variation in volumes within each sex that dwarfs the between-sexes difference and that there is a large amount of overlap such that many women are similar to many men. However, INAH-3 retook center stage when Simon LeVay (1991) reported that this cell group was smaller in gay men (suggesting questionable parallels with women) than in heterosexual men.

The next major chapter in this developing story came from research with twins. **Monozygotic** (identical) twins share identical genes because they come from one divided sperm-fertilized egg. In contrast, **dizygotic** (fraternal) twins share the same prenatal environment, but no more genes than any pair of siblings, because they developed from two independently fertilized eggs. If genes are involved, we would expect those who share more genes

[5]Although earlier research focused on a cluster of cells in the hypothalamus called the sexually dimorphic nucleus (SDN) in rats, there is no solid evidence for the existence of SDN in humans (Fausto-Sterling, 1992, pp. 244–247).

to be more likely to share their sexual orientation; in other words, we'd expect **concordance** between these two variables.

Pursuing this logic, researchers found that fully 52% of 56 monozygotic gay men had a gay twin brother, compared to only 22% of 54 dizygotic twin gay men and 11% of 57 non-genetically related adopted brothers (Bailey & Pillard, 1991). A similar pattern emerged for lesbians: 48% of monozygotic twins were both lesbian, 16% of dizygotic twins, and only 6% of adoptive sisters (J.M. Bailey et al., 1993). Although not all genetically identical women and men shared their sexual orientation (leaving plenty of room for environmental influences), the pattern is consistent with a genetic *component*: the stronger the genetic link, the more concordance there is with sexual orientation.

More recent, larger studies frame their data in terms of heritability. Using statistical procedures to compare twin correlations using the same logic about concordance that we just developed, **heritability** refers to the percentage of variability in a trait within a population that is due to genetic effects (ranging from zero, none, to 100%, i.e., totally genetically controlled). Kendler et al. (2000) reported a heritability estimate for sexual orientation of 62% for American men and women. Although a common pattern is to find that heritability in sexual orientation is stronger for men than for women (Mustanski & Bailey, 2003), a large population-based Australian study using an expanded definition of homosexuality found the reverse: 50 to 60% heritability for women and about 30% for men (Kirk et al., 2000).

Note that our interest has shifted here from a brain structure (the hypothalamus) to biological linkages in families, that is, to genes. The search for the "gay gene" is unlikely to come up with any single gene, but rather a *chromosomal region* (Mustanski & Bailey, 2003). Because some evidence points to transmission of sexual orientation through maternal lines, researchers have tended to focus on the X chromosome of men contributed by their mother. One particular *region*, X_q28, has proved somewhat promising for molecular biologists, although it has been ruled out as a potential site for lesbian development. In sum, the search for a "gay gene" is far from conclusive.

A second area where genes and heritability have attracted research attention concerns cognitive abilities. Here again concordance rates of monozygotic with dizygotic twins suggest some impact of genetic inheritance. Estimates of heritability in a recent study were 62% for general cognitive ability, 55% for verbal ability, 32% for spatial ability, 62% for speed of cognitive processing, and 52% for memory (McClearn & Johansson, 1997). However, there is a large leap from overall heritability to sex-linked heritability. For example, the search for a link between the X chromosome and visual-spatial ability turned up more disconfirming than supportive evidence (Halpern, 2000, pp. 144–148; Turkheimer & Halpern, 2009). Again, it seems likely that any search for genetic linkages with complex human behaviors will have to focus more broadly than on any single gene.

The corpus callosum and laterality. The human brain is divided into two structurally similar halves (**hemispheres**), popularly referred to as the left and right brains. Each hemisphere controls the opposite side of the body so that what we do with our left hand is controlled by our right hemisphere; with our right hand, by our left hemisphere. The two cerebral hemispheres are connected by the **corpus callosum**, a huge mass of nerve fibers. Anne Fausto-Sterling (1992, p. 228) draws an analogy between the corpus callosum and a phone cable connecting all of the United States with Europe. Thousands of connections

run through this cable; we might cut a few to see what happens, but we'd be lucky to link a general region in one country with another vague location in another.

Although speculation that great men have large corpus collosa dates back as far as 1908 (and E.A. Spitzka), recent interest took off with Roger Sperry's work with split-brain patients whose corpus callosa were severed (through damage or purposively to relieve severe symptoms of epilepsy) (taken from Halpern, 2000). Almost every beginning psychology textbook tells about split-brain patients whose verbal and spatial skills were disrupted when their hemispheres lost the ability to communicate. These studies suggest that the two hemispheres of the brain, although structurally parallel, may *process* information differently. **Hemispheric dominance** (lateralization) refers to the relatively *greater* importance of one hemisphere over the other in processing information, not the exclusive processing of information by one hemisphere.

Generally, researchers studying laterality propose *functional* differences in how women and men use their left and right hemispheres. It is argued that typically men show greater **specialization**, with the left side more active in handling verbal processes and the right side, visuospatial processing. In contrast, it is hypothesized that women use both hemispheres more equally to engage in both forms of cognitive processing, referred to as **bilateralization**.

Research evidence for this gender difference comes from triangulating evidence from a variety of sources (see Halpern, 2000, pp. 198-218). For example, if women indeed communicate more across hemispheres, we might expect to find evidence of larger corpus callosa in women than in men. Although highly controversial, a review comes to this conclusion (Bigler et al., 1997, cited in Halpern, 2000, p. 200). Furthermore, there are some animal studies that link the size of the adult corpus callosum to prenatal exposure to reproductive hormones.

Other studies uncover some gender differences in how strokes affect women and men; how brain activity while doing tasks differs for women and men; how interfering in a hemisphere's functioning (for example, by tapping one's hand) disrupts cognitive task performance; and how divided visual fields can present information to only one hemisphere. Overall reviews of these vast bodies of research are mixed, with some reviews confirming gender differences in laterality (Voyer, 1996) and others rejecting them (Sommer et al., 2004). The best conclusion at this time is that some small differences may exist on some specific tasks (some visual, auditory, and language tasks) (Halpern, 2000; Hines, 2004a; Hiscock et al., 2001; Voyer, 1996).

The best supported hypothesis to date about *why* gender differences in laterality may exist is the **cognitive crowding hypothesis** forwarded by Jerre Levy (1969). Levy proposes that spatial performance with its required precision is strengthened if one hemisphere is drawn on more heavily to process information with less interference from competing demands (e.g., specialized is better for spatial processing). In contrast, verbal processing, which is a more global skill, is hypothesized to be enhanced if more cortical space is given over to it, suggesting better verbal performance using bilateralization (favoring women). Thus, gender differences in cognitive skills (wherein spatial scores favor men; verbal, women) and lateralization (wherein specialization used by men favors spatial abilities; bilateralization used by women favors verbal abilities) map onto each other.

Overall, the picture remains murky. Handedness plays a role in lateralization (remember that the hemispheres control opposite sides of the body and hence the opposite hand).

More men than women are left-handed—although the vast majority of people throughout the world are right handed and different cultures and historic periods have different norms about enforcing right-handedness (Papadatou-Pastou et al., 2008). Even the menstrual cycle has been implicated, such that during menstruation right-hemisphere superiority has been found for women's face perception (Heister et al., 1989). Anne Fausto-Sterling (1992) points to wider variations within groups of women and within groups of men (**intragroup differences**) than exist between women and men (**intergroup differences**). In other words, an individual woman is just as likely to differ from another woman as from a man, and there are women and men who are alike. All this argues for some skepticism concerning presumed differences in both structure and functions of the brain, and the need for much more gender-sensitive research.

EVOLUTIONARY PSYCHOLOGY

Darwin's ideas about evolution by natural and sexual selection have made their way into psychology in the form of **evolutionary psychology** (Confer et al., 2010; Gowaty, 2001). For evolutionary psychologists, gender differences and similarities exist today because they proved to be *adaptive* solutions to problems of *survival* and *reproduction* faced by our ancestors (Kenrick et al., 2004). Like the hormonal and brain ideas we just explored, it is the presumed linkage between reproduction with childhood and adult behaviors that connects our interests in sex, gender, and sexuality with evolutionary thinking.

The evolutionary emphasis on reproduction as a fundamental drive readily leads us to consider sexual selection and parental investment; that is, the pressures women and men face regarding their own *genetic* continuation through reproduction. From an evolutionary perspective, differences between women and men are rooted in their differing amounts of **parental investment**. Because women bear the responsibilities of pregnancy and lactation (often overextended to all of childrearing), for women to successfully produce the next generation, they need to invest heavily in a limited number of offspring. Men can opt for a strategy of spreading their genes widely across multiple partners, or can choose to invest heavily (like women) in a select few (for whom they want to be assured of their own paternity). Interestingly, when modern men make a more selective choice, their offspring have a greater chance of survival and differences between women and men tend to be narrower (Geary, 1998).[6]

These differences in parental investment underlie differences in **sexual selection**; that is, how individuals choose a mate (or at least, someone to mate with). Two important parts of sexual selection are **intrasexual selection** (competition among members of the same sex for *prized* mates) and **epigamic selection** (choosing partners with features associated with likely reproductive success) (Kenrick et al., 2004). Three gendered implications of these evolutionary ideas that have received strong research attention involve (1) men's preferences for fertile women and women's preferences for successful breadwinners (mate selection), (2) relational jealousy, and (3) men's aggression and dominance as means to best other men in their competition for prized (fertile) women.

[6]Indeed, some fascinating research begins to connect the two strands of research we have been exploring (hormones and evolution). Men who were most affected by exposure to auditory, visual, and olfactory cues from newborn babies during prenatal classes experienced hormonal changes around the birth of their baby that may facilitate paternal behavior (Storey et al., 2000).

Mate Selection

Studies of mate selection draw on surveys in which respondents rate their preferences for characteristics of mates and/or rank their preferences, as well as on content analyses of personal ads. These studies converge on a consistent pattern wherein women value status and resources, and men look for attractiveness and health (Feingold, 1992; Shackelford et al., 2005).

The most famous data come from the International Mate Selection Project, which sampled about 5,000 women and 5,000 men from 37 cultures globally about their mate preferences (Buss, 1989). This survey identified four continua on which people base their preferences, each of which involves a tradeoff between two endpoints: Love *vs* Status/Resources; Dependable/Stable *vs* Good Looks/Health; Education/Intelligence *vs* Desire for Home/Children; and Sociability *vs* Similar Religion (Shackelford et al., 2005). Women and men differed on the first three of these, paralleling what evolutionary psychologists would predict. Women valued status/resources, dependability/stability, and education/intelligence in a long-term mate more than men. Conversely, men wanted good looks/health and desire for home and family more in a potential mate than did women.

A meta analysis of the data above confirmed the general universality of these patterns across cultures. Interestingly, although ambitiousness was more valued by women than men globally, North American women especially looked for this quality in their mates (Feingold, 1992). Using additional studies, this meta-analysis also showed large (socioeconomic status [SES] and ambitiousness, each with $d \approx -.70$) and small (character and intelligence ds $\approx -.30$) gender differences on selection ratings preferred by women and predicted by evolutionary psychology, but no gender differences on characteristics unrelated to parental investment's predictions (e.g., humor and personality ds $\approx -.10$). Additionally, these gender differences appeared in personal ads where women sought socioeconomic status ($d = -.57$) and character ($d = -.39$) more than men. These patterns held across generations from the 1940s through the end of the 1980s.

Relational Jealousy

Given evolutionary psychologists' speculation about sexual selection and parental investment, one might expect heterosexual men to be more concerned about sexual infidelity (sexuality without attachment) by a female partner (Is her child mine?), and heterosexual women about emotional infidelity (an intense emotional attachment) by a male partner (Will he stick around?). However, a recent meta-analysis concluded that when forced to choose which type of cheating is worse, both women and men picked emotional infidelity (Carpenter, 2012).

Furthermore, Christopher Carpenter (2012) found that ratings by gay men and lesbians paralleled those for heterosexuals—based on shared stereotyping of their partner. When one's partner is male (for gay men and heterosexual women), emotional infidelity is expected to lead to sexual infidelity, whereas sexual infidelity may occur without emotional attachment. In contrast, when one's partner is female (for lesbians and heterosexual men), a platonic, nonsexual emotional attachment is considered feasible, whereas a sexual, nonemotional attachment is not. Pulling all these patterns together, social explanations focused on social-cognitive appraisals of how threatening each type of infidelity is (Is it *just* sex?)

and on stereotyping of gender-expected involvement by one's partner seem to explain these findings better than an evolutionary perspective.

Male Dominance

One of the biggest differences in children's socialization has to do with the segregation of girls with girls and boys with boys. The social relationships that generally develop among girls and among boys are markedly different, in that dominance hierarchies involving a number of status-ranked boys, often engaged in open competition, are more common among boys than girls, who typically form friendship pairs (reviewed in Geary et al., 2003).

These dominance hierarchies stress the importance of physical size, skill, musculature, and social and cognitive competencies (leadership and mastery skills) that facilitate group performance (so my team can beat yours). The emotional needs of this arrangement demand aggression and fearlessness. Thus, big, tough individual boys are most prized. Coalition building among boys provides protection from other boys as well as within the group of friends. David Geary and his colleagues (2003) argue that these childhood lessons set the stage for adult behaviors that contribute to survival and reproductive success.

Notice how this thinking goes beyond the overly simplified equation of physically better men beat out other men and are chosen by fertile women. I use this example here because it highlights the growing complexity of evolutionary theories beyond individual choices into complex systems whereby what individuals do combines into patterns of behavior at a group level. It's this kind of thinking that begins to integrate evolution with culture (Kenrick et al., 2004).

Feminism and Evolutionary Psychology

The relationship between feminist and evolutionary psychologists historically has been an uneasy one (Bem, 1993; Bleier, 1984; Fausto-Sterling, 1992; Sayers, 1982). However, contemporary versions of evolutionary psychology have moved beyond claims of cross-cultural universality and beyond searches for single genes (now focused on polygenic explanations that include environmental input) to forward testable hypotheses and to integrate the importance of learning and socialization into explanations that include evolutionary components (Confer et al., 2010). Probably the best way to think about evolutionary psychology may be to see it as offering a potentially useful piece to a much bigger puzzle, especially when we want to ask not only how a mechanism works (the proximate explanation) but also *why* it exists (the ultimate explanation).

BIOLOGY, DIFFERENCE, AND POWER

I share many feminists' concerns about biological explanations for gender differences. I resent the disproportionate media attention they attract (Choi, 2001) and the objectivity they are almost automatically granted as "hard" science (Schiebinger, 1992). Most troubling, I worry about how rooting differences between women and men in **biological essentialism** can undermine progress toward gender and sexual equity (Bem, 1993).

Some very troubling ideas have come from these research areas. For example, exaggerated claims in the news media early in the 1980s about genetic determinants of math abilities misinformed some parents, who excused or even discouraged their daughters from succeeding at math because it just isn't in their natures (Eccles & Jacobs, 1986). Thornhill and Palmer's (2000) conclusion that men with few prospects for being chosen as mates (because of poverty and lack of education) are driven to rape to satisfy evolutionary urges is chilling. I cringe when I hear evolutionists talk about teenage boys whose unreciprocated dating preferences are said to focus on women in their twenties because they are fertile (Kenrick et al., 1996).

At these times, I need to remind myself that bad research occurs everywhere. We need to think about other ways to explain research and then test the alternatives. For example, Thornhill and Palmer's imprisoned rapists may come disproportionately from lower socioeconomic classes because they are more likely to be reported, caught, and convicted than men with more status and resources. I asked my then 14-year-old son about dating, and although he volunteered that a date with Halle Berry sounded awfully good, he thought it had more to do with who is sexualized in movies and on TV than mating (which then got too gross to talk about with his Mom!).

Good researchers are very clear about how their work showing heritability or permanent brain organization affected by prenatal hormones are NOT determinants of behavior, but rather establish predispositions or ranges of possibilities (Choi, 2001; Jordan-Young, 2010). No gene makes it impossible for girls to learn math! When we stop and think about it, this point seems obvious. But there's research to suggest that we all don't think about this point as deeply as we should. With hope, after reading this chapter you have a more informed base from which to think critically about these issues in all their complexity.

Folk Wisdom about Causality, Determinism, and Control

For example, consider how you feel when you see TV ads saying that your cholesterol levels come from diet and family (genes) and then going on to promote a pill. These ads are capitalizing on a common misperception that risks for illnesses with a genetic component cannot be controlled without taking a pill (Marteau & Senior, 1997). Although the biological representation of the causes of cholesterol levels is fundamentally true, some problems arise with how these facts are used and interpreted.

Turning to gender differences, Celeste Condit and her colleagues (2003) formed 17 focus groups where people came together to discuss several questions, including "Do males and females have the same genes?" Generally, people were savvy about knowing that the answer is more complex than "yes" or "no" given the reality that of the 23 **chromosomes** we all inherited, only one (typically XX or XY) is related to sex. The subsequent interpretation of what this means though divided participants into two camps: one that stressed "essential differences" and the other that emphasized "mostly similarity."

Folk theories about gender differences also vary across individuals in how much weight is given to biological causes. Most revealing is that people who stress biology are also likely to assume that gender differences will be difficult to eliminate (Martin & Parker, 1995; Yoder et al., 2007). As for attitudes about homosexuality, attributing homosexuality to biological causes only persuades people who were accepting in the first place (Boysen & Vogel, 2007).

Additionally, popular attitudes can confuse **heritability** with **innateness** (Mustanski & Bailey, 2003). For example, an attitude survey conducted with Americans in 1983 found that only 16% believed that "homosexuality is something people are born with" (innateness'). By 2000, when there had been more publicity about the presumed "gay gene," that percentage more than doubled to 35% (reported in Bem, 2000, p. 532). Innate traits are possessed at birth (green eyes); heritability refers to a predisposition or a tendency that *may* or *may not* develop. Thus, if sexual orientation was innate, its heritability score would be 100% (which it never is). My point is that by emphasizing biology as the cause of essentialized differences and by confusing heritability with innateness, lay people's interpretations of biological information about hormones, brain structures and functions, and genes can head down a path toward biological determinism (Bem, 1993), coming to accept the dictum that "anatomy is destiny."

Beyond popular attitudes, even the scientific community can be affected by folk wisdom about gender differences. In hindsight, the political biases of the scientific community are obvious in previously held, then rejected beliefs. For example, leading scientists once maintained that educating women would have the side effect of drying up their uteruses, leading to "race suicide" among exactly the people "best suited" to breed the next generation (see Gould, 1981). Today, feminist critics like Anne Fausto-Sterling (2000) caution that our assumptions about passive female development, that is, that without a Y chromosome a fetus will develop into a female by default (a conclusion slowly being challenged: see Hughes, 2004; Yao, 2005), is based more on biologists' expectations about women's passivity than on full explorations of other possibilities.[7] Where we do and don't look for biological and evolutionary evidence can reflect highly politicized choices.

Behavior Affects Biology

If you turn back to Figure 3.4, there's a vague gray line going back from behaviors to the brain and hormones. When we think of biology as a determinant of behavior, we often ignore the possibility of reverse influence. Some new strands of research are waking up to this "backwards" path, and some fascinating findings are beginning to emerge about the *reciprocal causality* between brains and behavior (Cacioppo & Berntson, 1992). I made these arrows shaded, not because they are less important, but rather to remind us how they often are understudied.

For example, we have seen that hormones may have organizational effects on the brain that are permanent by birth. However, brain development does not stop at birth. Although the total number of nerve cells may be established during the first half of gestation, glial cells (which are involved in making myelin, the electrical insulation for nerve fibers) and neural pathways continue to multiply across about the first 4 years of life (Fausto-Sterling, 1992, pp. 73–74). Even the shape and size of structures, like the corpus callosum (Burke & Yeo, 1994), change with age (Driesen & Raz, 1995; Murphy et al., 1996) and disease (Fausto-Sterling, 1992, p. 239).

We also tend to think of brain growth as something that happens through addition, and indeed this is true prenatally. The brain starts as a hollow tube, gradually adding new

[7]Another possibility suggests that estrogen (or other hormones produced by the ovaries) plays an active role in feminization and demasculinizing (see Collaer & Hines, 1995, for an overview).

nerve cells (estimated at a mind-boggling rate of a quarter of a million neurons per minute) that migrate out to their proper locations, until the brain assumes the adult shape we are accustomed to seeing (Kolb, 1989). At this point, the brain "overproduces" neurons and synaptic connections, both by as much as a factor of two. Much of brain development after birth involves the chiseling away of unused, excess cells and connections—something of a "use-it-or-lose-it" process. Such cell death and synaptic loss can continue at a slowed rate throughout adulthood, although most occurs throughout childhood. Brain development after birth, then, is more a *subtraction* of cells and connections, paradoxically at the same time that functions are expanding.

We might expect then that if the brain is damaged, some cells and connections that otherwise might have decayed may be retained and thus recover at least some of the functionality lost to the damage, especially for young children (Kolb, 1989). This ability to pick up lost functionality refers to the brain's **plasticity**. Furthermore, drawing on results that are far from conclusive, Mukerjee (1995) proposes that "sexual and other abuses may alter a brain region," specifically the hippocampus. Across all this evidence, the pattern is clear: *brains are not immutable and unreceptive to experiences*.

Environment can affect more of our bodies than just our brains. For example, a fascinating study of the menstrual cycles of college women living in dormitories found the cycles of roommates and close friends (defined as women who mutually reported spending lots of time together) converged across the first 4 months of dorm life (McClintock, 1971). Similar **menstrual synchrony** has been documented among lesbian couples (Weller & Weller, 1992). Thus, close social interaction among women may alter their menstrual cycles, suggesting that environment can change biology. Pursuing this reasoning further, even if biological sex differences in human brains are established, we still will be left with the proverbial chicken-or-egg question. Do brain differences cause variability in the behaviors of women and men, or do the variable experiences of women and men produce different brains?

Language: The Power to Name

We saw that feminist social constructionists look closely at language as a way to unobtrusively gauge how we think about various concepts and as shaping how we think about things. We defined sex in Chapter 1 as assuming a biological base and gender as connoting more social and cultural underpinnings. This chapter did a lot to blur the lines between sex and gender by showing that human hormones, brain structures and functions, and genes work inside a social environment. For example, even if estrogen levels do affect memory, there's training, memory aids, and individual variations that make the biological part (sex) only a piece of a complete explanation for gender differences in memory. It's impossible to completely separate out what causes intergroup memory differences between women and men. Rather sex and gender are so intertwined in working together throughout the lives of all individuals that they become inseparable. We really should talk about "sex&gender" combined in a **psychobiosocial model** (Halpern, 1997).

The same can be said for sexuality. Even if sexual orientation begins with a "gay gene," it certainly doesn't end there. Rather, it gets caught up in how we are raised ("Be feminine, wear a skirt and sit like a lady!"; "Big boys don't cry!") and what we feel is appropriate for women (dating men) and men (dating women). The lines dividing sex, gender, and sexual-

ity blur and likewise become inseparable in their influence on each of us so that we really should talk about "sex&gender&sexuality"—inseparably combined in ways paralleling what we explored previously about **intersectionality** (Diamond & Butterworth, 2008).

Rebecca Jordan-Young (2010, p. 15) captures this point by thinking about sex&gender&sexuality as three-ply yarn. Three-ply yarn is made up of three distinguishable yet intertwined strands that are fuzzy around the edges and that would be useless if separated. Additionally, this yarn has the potential to be woven into a theoretically infinite number of patterns and products, illustrating what scientists call the **norm of reaction**. A classic example from botanists (Hiesey et al., 1942 cited in Jordan-Young, 2010, p. 273) demonstrates how genetically identical clones of plants grow to look remarkably different in different climates. Thus *genetic expression* is a dynamic, environmentally contingent process that is responsive to developmental conditions and random events.

Furthermore, we saw that even the division of biological sex into two separate and inclusive categories, female and male, is not the way it really is. Everything from clitorises to penises, estrogen to androgens, bilateral to specialized lie along continua. Additionally, there is no one definitive characteristic that alone determines one's sex.

Now think how much more complex these continua become when we talk about markers of gender like femininity and masculinity and of sexuality like gay, bisexual, and heterosexual. Is there a defining feature that makes a person "feminine" or heterosexual? In fact, try to define sexuality.[8] Is it always about reproduction? What constitutes sexual behavior? Is it behavior alone that defines one's sexual orientation, or might it involve a complex array of behaviors, attitudes, identity, fantasies and desires, and feelings? And exactly when it is that a person crosses the line from being heterosexual to gay? For example, researchers have identified a "mostly straight" sexual identity among women that is separate from those of mostly straight, bisexual, and lesbian identities (Thompson & Morgan, 2008). With hope, none of these three basic notions about sex, gender, and sexuality are as simple now as they may have been when you started reading this chapter.

This last point raises some questions about how we should talk about the differences between girls/women and boys/men that we explored here. Are they "sex" differences or "gender" differences? Some authors make note of this dilemma and then fall back on the term "sex" because their focus is largely biological (Halpern, 2000). Although I applaud that they make this point, I think that the use of "sex" to denote anything other than clear biological markers (e.g., hormones) misses the point we are making about biology being not only just one piece of the puzzle but also inseparable from gender. Given the folk wisdom that readily can link biology to determinism, I have elected here to use the terminology of "gender" differences when referring to childhood and adult behaviors (cognitive abilities, etc.). With hope, this purposive use of language will help remind us that sex&gender cannot be studied in isolation.

CHAPTER SUMMARY

This chapter may raise more questions than it answers, but I find the ways it expands my thinking fascinating. Simple things like female or male, clitoris or penis, and gay or hetero-

[8]See the classroom exercise developed by medical anthropologist Carole Vance and described by Jordan-Young (2010, pp. 14-15).

sexual all become murkier. Despite this complexity, there are some simple and consistent messages to take away from this review.

First, continua rather than dimorphism better capture what sex, gender, and sexuality are. Second, none of these operates independently of the others. Some behaviors in which children and adults engage, from play though cognitive tasks, appear to rely, at least in part, on hormones, brain structures and functions, and genes (including the evolution of them). Although we separate our thinking about biology from environment and about nature from nurture, understanding gender differences really is a big puzzle with many interlocking pieces. These pieces represent biology and evolution, socialization (Chapter 4) and development across the life course (Chapter 5), individual differences, and current gender roles, expectations, and statues (Chapter 6). Furthermore, the picture these puzzle pieces make tells us about power, privilege, oppression, and systems of inequality (Chapter 7).

Ruth Hubbard (1990) brings this **dialectical model** to life most clearly with the following example, which also takes us into the next chapter on socialization.

> If a society puts half its children in dresses and skirts but warns them not to move in ways that reveal their underpants, while putting the other half in jeans and overalls and encouraging them to climb trees and play ball and other active outdoor games; if later, during adolescence, the half that has worn trousers is exhorted to "eat like a growing boy," while the half in skirts is warned to watch its weight and not get fat; if the half in jeans trots around in sneakers or boots, while the half in skirts totters about on spike heels, then these two groups of people will be biologically as well as socially different. Their muscles will be different, as will their reflexes, posture, arms, legs and feet, hand-eye coordination, spatial perception, and so on. They will also be biologically different if, as adults, they spend eight hours a day sitting in front of a visual display terminal or work on a construction job or in a mine…There is no way to sort out the biological and social components that produce these differences, therefore no way to sort nature from nurture, when we confront sex differences or other group differences in societies in which people, as groups, do not have equal access to resources and power and hence live in different environments (pp. 115–116).

SUGGESTED READINGS

Intersex Society of North America. *http://www.isna.org*

This website of the Intersex Society of North America is an excellent resource for current information translated into useful language for everyday readers as well as political action on issues of intersexuality.

Hines, M. (2004a). Androgen, estrogen, and gender: Contributions of the early hormone environment to gender-related behavior (pp. 9–37).

Hampson, E., & Moffat, S. D. (2004). The psychobiology of gender: Cognitive effects of reproductive hormones in the adult nervous system (pp. 38–64), in A. H. Eagly, A. E. Beall, & R. J. Sternberg (Eds.), *The psychology of gender (*2nd ed.). New York: Guilford.

Both chapters from the same graduate-level text give excellent, although densely packed, overviews of research on human hormones.

Halpern, D. F. (2000). *Sex differences in cognitive abilities* (3rd ed.). Mahwah, NJ: Erlbaum. (A 4th edition was released by Psychology Press in Sept. 2011.)

This clear and approachable book is probably the most authoritative resource for information about gender differences in cognitive abilities, including laterality.

Jordan-Young, R. (2010). Chapter 9: Taking context seriously. *Brain storm: The flaws in the science of sex differences* (pp. 236-268). Cambridge, MA: Harvard University Press.

This chapter explores how we need to take context into account when we draw conclusions from brain organization research, especially studies with CAH girls.

Mustanski, B. S., & Bailey, M. (2003). A therapist's guide to the genetics of human sexual orientation. *Sexual and Relationship Therapy, 18*, 429-436.

This brief article is sensitive and friendly to a lay reader interested in better understanding the "gay gene" and its implications for people's lives.

Gowaty, P. A. (2001). Women, psychology, and evolution. In R. K. Unger (Ed.), *Handbook of the psychology of women and gender* (pp. 53-65). New York: Wiley.

Patricia Gowaty writes most comprehensively about evolutionary psychology from a feminist perspective and in a style that is friendly for readers not well versed in evolutionary terminology.