3 Genes, Evolution, and Environment

Ask questions. . . be willing to wonder

If a trait is "genetic," is it inevitable?

Why do kittens, monkeys, toddlers, and grownups all love to play and "monkey around"?

Has evolution made men, but not women, naturally promiscuous?

OUTLINE

Think of all the ways in which human beings are alike. Everywhere, no matter what their backgrounds or where they live, people love, work, argue, dance, sing, complain, and gossip. They rear families, celebrate marriages, and mourn losses. They reminisce about the past and plan for the future. They help their friends and fight their enemies. They smile with amusement, frown with displeasure, and glare in anger. Where do all these commonalities come from?

Think of all the ways in which human beings differ. Some are extroverts, always ready to make new friends or speak up in a crowd; others are shy and introverted, preferring the safe and familiar. Some are ambitious and enterprising; others are placid, content with the way things are. Some take to academics like a cat to catnip; others struggle in school but have plenty of street smarts and practical know-how. Some are overwhelmed by even petty problems; others remain calm and resilient in the face of severe difficulties. Where do all these differences come from?

For many years, psychologists addressing these questions tended to fall into two camps. On one side were the nativists, who emphasized genes and inborn characteristics, or nature; on the other side were the empiricists, who focused on learning and experience, or nurture. Edward L. Thorndike (1903) staked out the first position when he claimed that "in the actual race of life . . . the chief determining factor is heredity." But in words that became famous, his contemporary, behaviourist John B. Watson (1925), insisted that experience could write virtually any message on the tabula rasa, the blank slate, of human nature: "Give me a dozen healthy infants, well-formed, and my own specified world to bring them up in and I'll guarantee to take any one at random and train him to become any type of specialist I might select—doctor, lawyer, artist, merchant-chief and yes, even beggar-man and thief, regardless of his talents, penchants, tendencies, abilities, vocations, and race of his ancestors."

In this chapter, we examine the contributions of both nature and nurture in shaping our human commonalities and our individual differences. We will focus largely on findings from two related areas: evolutionary psychology and behavioural genetics. Researchers in **evolutionary psychology** emphasize the evolutionary mechanisms that might help explain commonalities in language learning, attention, perception, memory, sexual behaviour, emotion, reasoning, and many other aspects of human psychology. Researchers in **behavioural genetics** attempt to tease apart the relative contributions of heredity and environment to explain individual differences in personality, mental ability, and other characteristics.

evolutionary psychology A field of psychology emphasizing evolutionary mechanisms that may help explain human commonalities in cognition, development, emotion, social practices, and other areas of behaviour.

behavioural genetics An interdisciplinary field of study concerned with the genetic bases of individual differences in behaviour and personality.

The long and short of it: Human beings are both similar and different.

The long and short of it: Human beings are both similar and different. Keep in mind, however, that virtually no one argues in terms of nature *versus* nurture anymore. Scientists today understand that heredity and environment constantly interact to produce our psychological traits and even most of our physical ones. This interaction works in two directions. First, genes affect the kinds of experiences we have: A teenager with a genetic aptitude for schoolwork may be more likely than other kids to join a spelling-bee team and get books and science kits as birthday presents. These experiences reward and encourage the development of academic skills. Conversely, although most people don't realize it, experience also affects our genes: Stress, diet, emotional events, and hormonal changes can all influence which genes are active or inactive at any given time over a person's lifetime (Fraga et al., 2005; Mischel, 2009). The study of this type of stable change in gene expression (that does not involve changes in the underlying DNA structure) is called *epigenetics*. Try, then, as you read this chapter, to resist the temptation to think of nature and nurture in either–or terms.

Learning Objectives

1. Describe what the chemical code in our genes encodes for.
2. Contrast what a complete map of the human genes reveals—and does not reveal.
3. Compare how gene expression can change over the lifespan. Identify the promise and limitations of epigenetics.

Unlocking the Secrets of Genes

Simulate the **Experiment** *DNA Replication* in **MyPsychLab**

Let's begin by looking at what genes are and how they operate. **Genes**, the basic units of heredity, are located on **chromosomes**, rod-shaped structures found in the centre (nucleus) of every cell of the body. Each sperm cell and each egg cell (ovum) contains 23 chromosomes, so when a sperm and egg unite at conception, the fertilized egg and all the body cells that eventually develop from it (except for sperm cells and ova) contain 46 chromosomes, arranged in 23 pairs.

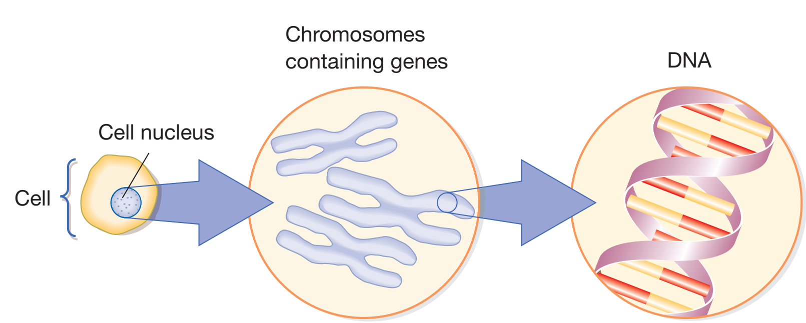
Chromosomes consist of threadlike strands of **deoxyribonucleic acid (DNA)** molecules, and genes consist of small segments of this DNA. Each human chromosome contains thousands of genes, each with a fixed location. Collectively, all the genes together—the best estimates put the number at around 25 000—are referred to as the human **genome**. Most of these genes are found in other animals as well, but others are uniquely human, setting us apart from chimpanzees, wasps, and mice. Many genes contribute directly to a particular trait, but others work indirectly by switching other genes on or off throughout a person's life. Everyone inherits many genes in the same form as everyone else; other genes vary, contributing to our individuality.

genes The functional units of heredity; they are composed of DNA and specify the structure of proteins.

chromosomes Within every cell, rod-shaped structures that carry the genes.

deoxyribonucleic acid (DNA) The chromosomal molecule that transfers genetic characteristics by way of coded instructions for the structure of proteins.

genome The full set of genes in each cell of an organism (with the exception of sperm and egg cells).



Within each gene, four basic chemical elements of DNA—the bases adenine, thymine, cytosine, and guanine, identified by the letters A, T, C, and G—are arranged in a particular order: for example, ACGTCTCTATA. . . . This sequence may contain thousands or even tens of thousands of "letters," which together constitute a code for the synthesis of one of the many proteins that affect virtually every aspect of the body, from its structure to the chemicals that keep it running. But this is a simplification. Many genes can make more than one protein, depending on when and where different "coding" segments of DNA on the gene are activated. Thus our measly 25 000 or so genes—barely more than a common worm has—are able to produce hundreds of thousands of different proteins (Pennisi, 2005).

genetic marker A segment of DNA that varies among individuals, has a known location on a chromosome, and can function as a genetic landmark for a gene involved in a physical or mental condition.

Identifying even a single gene is a daunting task; biologist Joseph Levine and geneticist David Suzuki (1993) once compared it to searching for someone when all you know is that the person lives somewhere on earth. However, new technologies now allow scientists to survey hundreds of thousands of "letters" at once instead of looking for one gene at a time. Using powerful computer programs, scientists can compare the genes of people who share a particular disease or trait with those of people who do not have it. A catalogue has been developed that describes millions of patterns of human genetic variation so that researchers can study the consequences of those variations. One method, which has been used to search for the genes associated with many physical and mental conditions, involves doing *linkage studies*. These studies take advantage of the tendency of genes lying close together on a chromosome to be inherited together across generations. The researchers start out by looking for a **genetic marker**, a DNA segment that varies considerably among individuals and whose location on the chromosome is already known. They then look for patterns of inheritance of these markers in large families in which a condition—say, depression or impulsive violence—is common. If a marker tends to exist only in family members who have the condition, then it can be used as a genetic landmark: The gene involved in the condition is apt to be located nearby on the chromosome, so the researchers have some idea where to search for it. The linkage method was used, for example, to locate the gene responsible for Huntington's disease, a fatal neurological disorder that affects motor control, intellectual functioning, and memory (Huntington's Disease Collaborative Research Group, 1993). Although in this instance only one gene was involved, the search took a decade of painstaking work.

In 2000, after years of heated competition, an international collaboration of researchers called the Human Genome Project and a private company, Celera Genomics, both announced that they had completed a rough draft of a map of the entire human genome, and since then the map has been greatly refined. Using high-tech methods, researchers have identified the sequence of nearly all 3 billion units of DNA (those As, Cs, Ts, and Gs) and have been able to determine the boundaries between genes and how the genes are arranged on the chromosomes (see Figure 3.1). This project has been costly and time-consuming, but it reflects the view among many scientists that the twenty-first century will be the century of the gene.

Even when researchers locate a gene, however, they do not automatically know its role in physical or psychological functioning. Usually, locating a gene is just the first tiny step in understanding what it does and how it works. Also, be wary of media reports implying that some gene is the *only* one involved in a complex psychological ability or trait, such as autism or shyness. It seems that nearly every year brings another report about some gene that supposedly explains a human trait. A few years back, newspapers even announced the discovery of a "worry gene." Don't worry about it! Most human traits, even such seemingly straightforward ones as height and eye colour, are influenced by more than one gene pair. Psychological traits are especially likely to depend on multiple genes, with each one accounting for just a small part of the variance among people. Conversely, any single gene is apt to influence many different behaviours. So at this point, all announcements of a "gene for this" or a "gene for that" should be viewed with extreme caution.

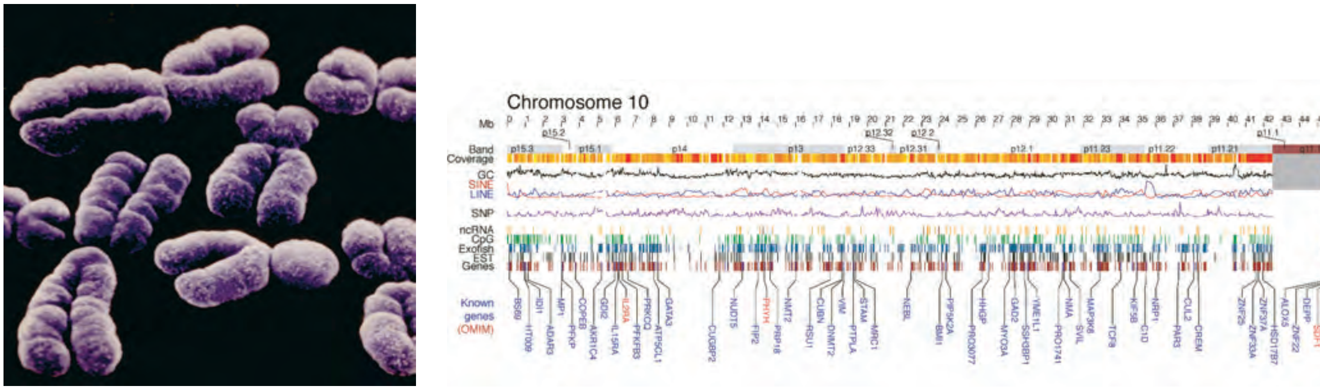


FIGURE 3.1 Mapping Human Genes
Genes are located on chromosomes, some of which are shown on the left, magnified almost 55 000 times. On the right, a small portion of the map for chromosome 10 shows 52 genes identified by the Human Genome Project, including some that have been linked to prostate cancer, leukemia, and obesity.

Recite & Review

Recite: We've been through some technical material, so say out loud everything you can remember about *evolutionary psychology*, *behavioural genetics*, *genes*, *chromosomes*, *DNA*, *the genome*, *bases*, *genetic markers*, linkage studies, and epigenetics.

Review: Next, go back and reread this section.

Now take this *Quick Quiz:*

The Human Genome Project has not discovered any quiz-taking genes.

1. What does it mean to say that the gene–environment interaction works in both directions?
2. The basic unit of heredity is called a (a) gene, (b) chromosome, (c) genome, (d) DNA molecule.
3. What does the code within a gene encode for?
4. *True or false*: Most human genetic traits depend on a single gene.

Answers:

1. Genes affect the environments we experience, and environmental factors affect the activity of genes over a person's lifetime. **2.** a **3.** the synthesis of a particular protein **4.** False

"Heard the one about the three humans who went into a bar?" Evolutionary psychologists are interested in the origins of many human behaviours, such as smiling and laughter, which are universal among primates and are part of our shared evolutionary heritage.

Learning Objectives

4 Describe the meaning of evolution.

5 Document one reason that some traits become more common during evolution and others become less common.

6 Explain why some evolutionary psychologists assume the existence of innate "mental modules" in the human mind.

7 List some innate human characteristics.

The Genetics of Similarity

What accounts for the similarities among all human beings everywhere in the world, such as the universal capacity for language or loyalty to a family or clan? Evolutionary psychologists believe the answer lies partly in genetic dispositions that developed during the evolutionary history of our species. As British geneticist Steve Jones (1994) writes, "Each gene is a message from our forebears and together they contain the whole story of human evolution."

Evolution and Natural Selection

To read the messages from the past that are locked in our genes, we must first understand the nature of evolution itself. **Evolution** is basically a change in gene frequencies within a population, a change that typically takes place over many generations. As particular genes become more common or less common in the population, so do the characteristics they influence. These developments account for changes within a species, and when the changes are large enough they can result in the formation of new species.

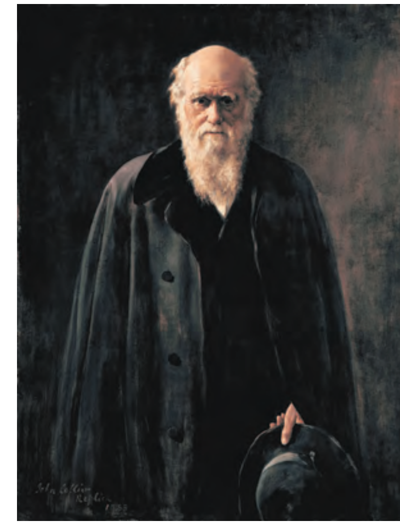
Why do gene frequencies in a population change? Why don't they remain static from one generation to another? One reason is that during the division of the cells that produce sperm and eggs, if an error occurs in the copying of the original DNA sequence, genes can spontaneously change, or undergo **mutation**. In addition, during the formation of a sperm or an egg, small segments of genetic material cross over (exchange places) from one member of a chromosome pair to another, before the final cell division. As genes spontaneously mutate and recombine during the production of sperm and eggs, new genetic variations—and therefore potential new traits—keep arising.

But that is only part of the story. According to the principle of **natural selection**, first formulated in general terms by the British naturalist Charles Darwin in *On the Origin of Species* (1859/1964), the fate of these genetic variations depends on the environment. Darwin did not actually know about genes, as their discovery had not yet been widely publicized, but he realized that a species' characteristics must somehow be transmitted biologically from one generation to the next.

The fundamental idea behind natural selection is this: If, in a particular environment, individuals with a genetically influenced trait tend to be more successful than other individuals in finding food, surviving the elements, and fending off enemies—and therefore better at staying alive long enough to produce offspring—their genes will become more and more common in the population. Their genes will have been "selected" by reproductive success, and over many generations these genes may even spread throughout the species. In contrast, individuals whose traits are not as adaptive in the struggle for survival will not be as "reproductively fit": They will tend to die before reproducing, and therefore their genes, and the traits influenced by those genes, will become less and less common and eventually may even disappear.

Scientists debate how gradually or abruptly evolutionary changes occur and whether competition for survival is always the primary mechanism of change, but they agree on the basic importance of evolution. Over the past century and a half, Darwin's ideas have been resoundingly supported by findings in anthropology, botany, and molecular genetics (Coyne, 2009). Scientists have watched evolutionary developments occurring before their very eyes in organisms that change rapidly, such as microbes, insects, and various plants. Researchers have even identified specific genes that account for evolutionary changes that have occurred in animals in the wild, such as the transformation of mice and lizards from light coloured to dark coloured (or vice versa) as the animals have migrated into different environments (Hoekstra et al., 2006; Rosenblum, 2005). They have also observed rapid evolutionary changes due to human activity. For example, the horns of bighorn rams have been getting smaller because of trophy hunting, which removes animals with larger horns from the breeding population (Coltman et al., 2003).

However, this "survival of the fittest" account of evolution cannot explain all the physical and behavioural traits that reflect a gene's success (that is, increase or decrease within a population). For example, why does a peacock (but not the female of the same species, the peahen) have such an incredibly large and colourful tail? Certainly not to



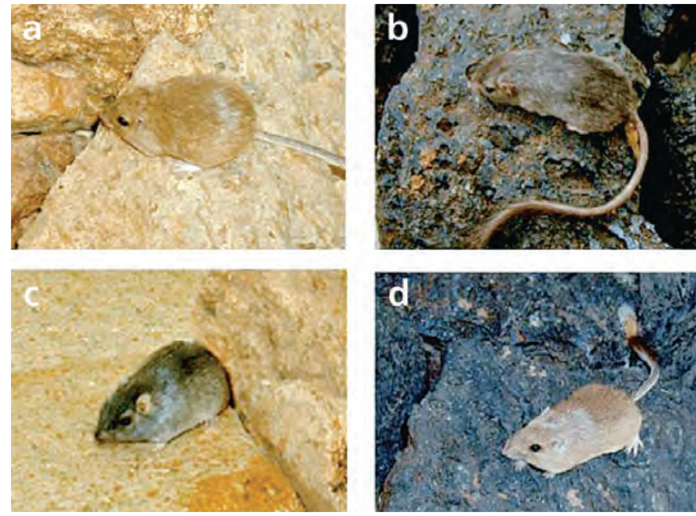
Darwin's image can be found on countless T-shirts, bumper stickers, and mugs. His theory of evolution forms the basis of modern biology and has had a growing influence in psychology.

Simulate the **Experiment** *Mechanisms of Evolution* in **MyPsychLab**

evolution A change in gene frequencies within a population over many generations; a mechanism by which genetically influenced characteristics of a population may change.

mutation Changes in genes, sometimes due to an error in the copying of the original DNA sequence during the division of the cells that produce sperm and eggs.

natural selection The evolutionary process in which individuals with genetically influenced traits that are adaptive in a particular environment tend to survive and to reproduce in greater numbers than do other individuals; as a result, their traits become more common in the population.



Natural selection allows animals to survive by adapting to the environment. In the deserts of Arizona, most rock pocket mice are sandy-coloured and are well camouflaged against the beige rocks they scamper over (a). Their colouring therefore protects them against owls and other predators. But in areas where ancient lava flows have left large deposits of black rock, the same species has evolved to be dark-coated and thus equally well disguised (b). You can see how vulnerable these mice are when their coats do *not* blend with the colour of the rocks (c and d). Researchers have identified the gene involved in the evolution of dark coloration in these mice (Nachman, Hoekstra, & D'Agostino, 2003).

avoid being spotted by predators! Darwin himself was puzzled by some of the physical traits he observed in nature and eventually became dissatisfied with natural selection as the only cause (or agent) of evolution. In Darwin's second book on evolution, *The Descent of Man* (1874), he proposed another type of selection: *sexual selection*. In natural selection, nature determines which genes survive and reproduce, and which genes disappear from the planet. In sexual selection, the members of either the other sex or the same sex, with which one is competing, determine a gene's fate. Two types of sexual selection exist:

- ***Intersexual selection.*** In this type, a member of one sex chooses a mate from the other sex on the basis of certain characteristics. For males, the choice appears to be most influenced by physical factors such as attractiveness and youth. For females, the choice is similarly influenced by physical factors, such as height and muscularity, but the resources that the male has access to also come into play. We will explore the tactics of intersexual selection later in this chapter.
- ***Intrasexual selection.*** In this type, members of the same sex compete for a partner of the other sex. Males might compete with each other by becoming more muscular or acquiring and displaying resources (such as wealth), whereas females might compete by enhancing their appearance and youthful look through such techniques as hair colouring or using makeup.

A renewed interest in sexual selection over the past 20 years has led to numerous "culturally driven" behaviours being reexamined from an evolutionary framework. In his book *The Mating Mind: How Sexual Choice Shaped the Evolution of Human Nature*, Geoffrey Miller hypothesizes that a number of behaviours, such as artistic innovation, music, and humour, are the result of sexually selected psychological traits dating back to the Pleistocene epoch (Miller, 2000). In order to excel in these areas, one requires considerable intelligence and creativity. These are also traits that are indicative of high genetic quality when viewed in the context of mate selection. In fact, the trait "artistic intelligence" ranked third out of nine (behind kindness and being socially exciting) in a comprehensive survey of preferred partner traits for both males and females (Buss & Barnes, 1986). Thus, an exceptional musician, imaginative painter, or witty comedian may attain higher reproductive success than a physically comparable counterpart owing to enhanced creative intelligence.

Traits and Preferences. Evolutionary biologists often start with an observation about some characteristic and then try to account for it in evolutionary terms. For example, why do male peacocks have such fabulous and flamboyant feathers while females look so drab and dull? Those long plumes certainly did not help the males avoid predators! The evolutionary answer is that during the history of the species, males who put on a flashy display (evidence that they had "good genes" and could afford to carry around the extra plumage) were better able to attract females. In contrast, a female peacock did not have to put on such a display to attract competing males. Instead, all she had to do was hang around and pick the best potential mate: the guy with the best genes and fanciest feathers. She didn't even have to dress up!

Evolutionary psychologists work in the same way as biologists, but some take a slightly different tack: They start by asking what sorts of challenges human beings might have faced in their prehistoric past—say, having to decide which foods were safe to eat, or needing to size up a stranger's intentions quickly. Then they draw inferences about the behavioural tendencies that might have been selected because they helped our forebears solve these survival problems and enhanced their reproductive fitness. (They make no assumption about whether the behaviour is adaptive or intelligent in the *present* environment.) Finally, they do research to see if those tendencies actually exist throughout the world.

For example, our ancestors' need to avoid eating poisonous or rancid food might have led eventually to an innate dislike for bitter tastes and rotten smells; those individuals who happened to be born with such dislikes would have stood a better chance of surviving long enough to reproduce. Similarly, it made good survival sense for our ancestors to develop an innate capacity for language and an ability to recognize faces and emotional expressions. But they would not have had much need for an innate ability to read or drive, inasmuch as books and cars had not yet been invented (Pinker, 1994).

Mental Modules. For many evolutionary psychologists, a guiding assumption is that the human mind is not a general-purpose computer waiting to be programmed. Instead, they say, it developed as a collection of specialized and independent **mental modules** to handle specific survival problems, such as the need to locate food or find a mate (Buss, 1995, 1999; Cosmides, Tooby, & Barkow, 1992; Marcus, 2004; Mealey, 1996; Pinker, 2002). A particular module may involve several dispersed but interconnected areas of the brain, just as a computer file can be fragmented on a hard drive (Pinker, 1997). Critics worry that the idea of mental modules is no improvement over instinct theory, the once-popular notion in psychology that virtually every human activity and capacity, from cleanliness to cruelty, is innate. Frans de Waal (2002), an evolutionary theorist who believes that someday all psychology departments will have a picture of Darwin hanging on the wall, has accused some of his colleagues who argue for mental modules of mistakenly assuming that if a trait exists and has a genetic component, then it must be adaptive and must correspond to a module. This assumption, he points out, is incorrect: Male pattern baldness and pimples, for example, are not particularly adaptive! Many evolved and inherited traits are merely by-products of other traits (for example, your bellybutton is a by-product of being a placental mammal), and some can even be costly; the problems that many people have with aching backs are no doubt an

mental modules A collection of specialized and independent sections of the brain, developed to handle specific survival problems, such as the need to locate food or find a mate.

THINKING CRITICALLY

Don't Oversimplify

Many people oversimplify evolutionary theory by concluding that if a trait exists, it must have aided survival by serving some beneficial purpose. Not so! Baldness, for example, may be beautiful, but it is not necessarily adaptive.

unfortunate consequence of our evolved ability to walk on two feet. To understand our evolutionary legacy, de Waal argues, we must consider not just individual traits in isolation but also the whole package of traits that characterizes the species. This is as true for psychological traits as for physical ones.

Those who subscribe to the modules approach respond that evidence from psychology and other disciplines can distinguish behaviour that has a biological origin from behaviour that does not. As Steven Pinker (1994) explains, if a mental module for some behaviour exists, then neuroscientists should eventually discover the brain circuits or subsystems associated with it. Further, he adds, "When children solve problems for which they have mental modules, they should look like geniuses, knowing things they have not been taught; when they solve problems that their minds are not equipped for, it should be a long hard slog."

The debate over modules will undoubtedly continue. But whether or not modules are the best way to describe traits that appear to be inherited, you should be careful to avoid the common error of assuming that if some behaviour or trait exists, it must be adaptive.

Innate Human Characteristics

Because of the way our species evolved, many abilities, tendencies, and characteristics are either present at birth in all human beings or develop rapidly as a child matures. These traits include not just the obvious ones, such as the ability to stand on two legs or to grasp objects with the forefinger and thumb, but also less obvious ones. Here are just a few examples:

1 **Infant reflexes.** Babies are born with a number of reflexes—simple, automatic responses to specific stimuli. For example, all infants will suck something put to their lips; by aiding nursing, this reflex enhances their chances of survival.

2 **An interest in novelty.** Novelty is intriguing to human beings and many other species. If a rat has had its dinner, it will prefer to explore an unfamiliar wing of a maze rather than the familiar wing where food is. Human babies reveal a surprising interest in looking at and listening to unfamiliar things—which, of course, includes most of the world. A baby will even stop nursing momentarily upon seeing someone new.

3 **A desire to explore and manipulate objects.** All birds and mammals have this innate inclination. Primates, especially, like to "monkey" with things, taking them apart and scrutinizing the pieces, apparently for the sheer pleasure of it (Harlow, Harlow, & Meyer, 1950). Human babies shake rattles, bang pots, and grasp whatever is put into their tiny hands. For human beings, the natural impulse to handle interesting objects can be overwhelming, which may be one reason why the command "Don't touch" is so often ignored by children, museum-goers, and shoppers.

4 **An impulse to play and fool around.** Think of kittens, puppies, lion cubs, panda cubs, and young primates who will play with and pounce on each other all day until hunger or naptime calls. Play and exploration may be biologically adaptive because they help members of a species find food and other necessities of life and learn to cope with their environments. Indeed, the young of many species enjoy *practice play*, behaviour that will be used for serious purposes when they are adults (Vandenberg, 1985). A kitten, for example, will stalk and attack a ball of yarn. In human beings, play teaches children how to get along with others and gives them a chance to practise their motor and linguistic skills (Pellegrini & Galda, 1993).

All primates, including human beings, are innately disposed to explore the environment, manipulate objects, play, and "monkey around."

5 **Basic cognitive skills.** Many evolutionary psychologists believe that people are born with abilities that make it easy to learn to interpret the expressions and gestures of others, identify faces, figure out what others are thinking or feeling, distinguish plants from animals, distinguish living from nonliving things, and acquire language (Geary & Huffman, 2002). Young infants have even been credited with a rudimentary understanding of number (Izard et al., 2009). Of course, tiny infants cannot count. By the age of only one week, however, they will spend more time looking at a new set of three items after getting used to a set of two items, or vice versa, which means that they can recognize the difference. By seven months, most infants prefer to look at videotapes in which the number of adults mouthing a word (two or three adults) matches the number of voices saying the word in synchrony with the images (Jordan & Brannon, 2006). By 18 months, infants know that four is more than three, which is more than two, which is more than one—suggesting that the brain is designed to understand "more than" and "less than" relations for small numbers. Evolutionary psychologists believe that these and other fundamental cognitive skills evolved because they were useful to our ancestors and aided their survival.

Although most archaeological evidence suggests that humans have spent the vast majority of their time on earth as hunter–gatherers on the African savannah (Orians & Heerwagen, 1992), the natural and sexual selection pressures that existed in this environment were quite different from the pressures we face today. For example, on the savannah, vitamins would have been hard to come by. One of the best sources would have been fruits, which were some of the sweetest foods available. Therefore, individuals preferring (and seeking) sweet foods would have been more likely to survive and reproduce. Since our ancestors were the ones who preferred sweets, so do we. However, we now often satisfy that preference with candy, not fruit. A behaviour that *was* adaptive is now maladaptive. Roger Bingham was probably thinking of such ancestral carry-overs when he wrote, "We live in the space age with a brain from the stone age."

In other chapters, we will consider the adaptive and evolutionary aspects of sensory and perceptual abilities (Chapter 6), learning (Chapter 7), ethnocentrism (Chapter 8), cognitive biases (Chapter 9), memory (Chapter 10), emotions and emotional expressions (Chapter 11), stress reactions (Chapter 11), the tendency to gain weight when food is plentiful (Chapter 12), and attachment (Chapter 13). For now, let us look more closely at an are of particular interest to evolutionary psychologists: the nature of mating practices around the world.

Recite & Review

Recite How evolved is your understanding of evolutionary psychology? To find out, say aloud what you have learned about *evolution*, *mutation*, *natural selection*, *mental modules*, and innate human characteristics.

Review: Next, go back and reread this section.

Now take this *Quick Quiz:*

1. What two processes during the formation of sperm and eggs help explain genetic changes within a population?
2. Which is the best statement of the principle of natural selection? (a) Over time, the environment naturally selects some traits over others. (b) Genetic variations become more common over time if they affect traits that are adaptive in a particular environment. (c) A species constantly improves as parents pass along their best traits to their offspring.
3. Many evolutionary psychologists believe that the human mind evolved as (a) a collection of specialized modules to handle specific survival problems; (b) a blank slate; (c) a collection of specific instincts for every human activity or capacity.
4. Which of the following is not part of our biological heritage? (a) a sucking reflex at birth; (b) a motive to explore and manipulate objects; (c) a lack of interest in novel objects; (d) a love of play.

Answers:

1. spontaneous genetic mutations and crossover of genetic material between members of a chromosome pair, which occur before the final cell division **2.** b **3.** a **4.** c

Learning Objectives

8 Contrast how evolutionary psychologists explain male–female differences in courtship and mating.

9 List some problems with evolutionary theories of courtship and mating preferences.

10 Identify the basic issue that divides evolutionary psychologists and their critics.

Our Human Heritage: Courtship and Mating

Most psychologists agree that the evolutionary history of our species has made certain kinds of learning either difficult or easy. Most acknowledge that simple behaviours, such as smiling or preferring sweet tastes, resemble instincts, behaviours that are relatively uninfluenced by learning and that occur in all members of the species. And most agree that human beings inherit some of their cognitive, perceptual, emotional, and linguistic capacities. But social scientists disagree heartily about whether biology and evolution can help account for complex social customs, such as warfare, cooperation, and altruism (the willingness to help others). Nowhere is this disagreement more apparent than in debates over the origins of male–female differences in sexual behaviour, so we are going to focus here on that endlessly fascinating topic.

Evolution and Sexual Strategies

In 1975, one of the world's leading experts on ants, Edward O. Wilson, published a book that had a big impact. It was titled *Sociobiology: The New Synthesis*, the "synthesis" being the application of biological principles to the social and sexual customs of both nonhuman animals and human beings. **Sociobiology** became a popular topic for researchers and the public, generating great controversy.

sociobiology An interdisciplinary field that emphasizes evolutionary explanations of social behaviour in animals, including human beings.

Sociobiologists contend that evolution has bred into each of us a tendency to act in ways that maximize our chances of passing on our genes, and to help our close biological relatives, with whom we share many genes, do the same. In this view, just as nature has selected physical characteristics that have proven adaptive, so it has selected psychological traits and social customs that aid individuals in propagating their genes. Customs that enhance the odds of such transmission survive in the form of kinship bonds, dominance arrangements, taboos against female adultery, and many other aspects of social life.

In addition, sociobiologists believe that because the males and females of most species have faced different kinds of survival and mating problems, the sexes have evolved to differ profoundly in aggressiveness, dominance, and sexual strategies (Symons, 1979; Trivers, 1972). In many species, they argue, it is adaptive for males to compete with other males for access to young and fertile females, and to try to win and then inseminate as many females as possible. The more females a male mates with, the more genes he can pass along. (The human record in this regard was achieved by a man who fathered 899 children [Daly & Wilson, 1983]. What else he did with his time is unknown.) But according to sociobiologists, females need to shop for the best genetic deal, as it were, because they can conceive and bear only a limited number of offspring. Having such a large biological investment in each pregnancy, females cannot afford to make mistakes. Besides, mating with a lot of different males would produce no more offspring than staying with just one. So females try to attach themselves to dominant males who have resources and status and are likely to have "superior" genes. The result of these two opposite sexual strategies, in this view, is that males generally want sex more often than females do; males are often fickle and promiscuous, whereas females are usually devoted and faithful; males are drawn to sexual novelty and even rape, whereas females want stability and security; males are relatively undiscriminating in their choice of sexual partners, whereas females are cautious and choosy; and males are competitive and concerned about dominance, whereas females are less so.

Watch the **Video** *Thinking Like a Psychologist: Evolutionary Psychology* in **MyPsychLab**

Evolutionary psychologists generally agree with these conclusions, but whereas sociobiologists often study nonhuman species and argue by analogy, many evolutionary psychologists consider such analogies simplistic and misleading. For example, because male scorpion flies force themselves on females, some sociobiologists have drawn an analogy between this behaviour and human rape and have concluded that human rape must have the same evolutionary origins and reproductive purposes (Thornhill & Palmer, 2000). But this analogy does not bear scrutiny. Human rape has many motives, including, among others, revenge, sadism, and conformity to peer pressure (see Chapter 12). It is often committed by high-status men who could easily find consenting sexual partners. All too frequently its victims are children or the elderly, who do not reproduce. And sadistic rapists often injure or kill their victims, hardly a way to perpetuate one's genes. In general, therefore, evolutionary psychologists rely less on comparisons with other species than sociobiologists do, focusing instead on commonalities in human mating and dating practices around the world. As a result of this difference, evolutionary psychologists also rely on different assumptions than sociobiologists do. Although both groups assume that human bodies and behaviours have been subject to evolutionary selection pressures, Darwin's account of speciation (the origin of new species) is irrelevant to evolutionary psychologists. Instead, the evolutionary psychologists simply assume that—as mentioned previously in this chapter—humans have spent the vast majority of their time on earth living as hunter–gatherers, probably on the African savannah.

Nevertheless, both groups emphasize the evolutionary origins of many human sex differences that appear to be universal, or at least very common. In one massive project, 50 scientists studied 10 000 people in 37 cultures located on six continents and five islands (Buss, 1994;

THINKING CRITICALLY

Consider Other Interpretations

Evolutionary theories have been criticized on conceptual and methodological grounds. Do genes hold culture on a tight leash; a long, flexible one; or none at all?

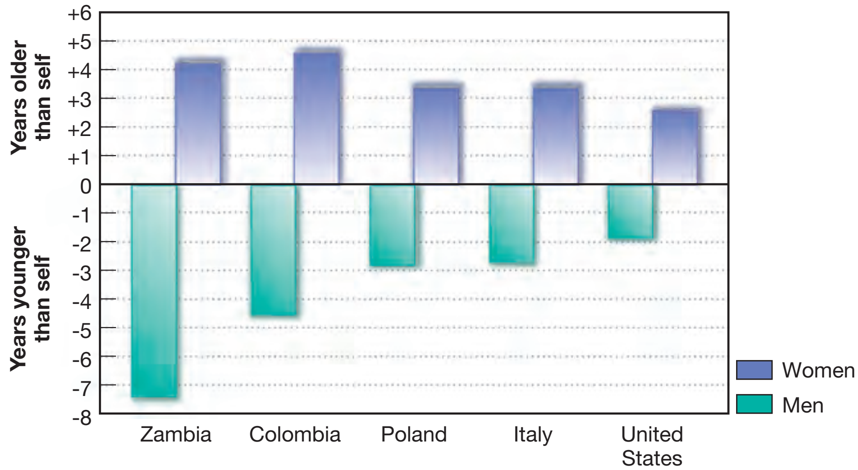


FIGURE 3.2 Preferred Age in a Mate
In most societies, men say they prefer to marry women younger than themselves, whereas women prefer men who are older (Buss, 1995). Evolutionary psychologists attribute these preferences to male concern with a partner's fertility and female concern with a partner's material resources and status. Although people may make comments about age differences when the man is much older than the woman, as in the case of Canadian singer Celine Dion and her much older husband, René Angélil, people are far more apt to make disapproving comments when the woman is much older.

Schmitt, 2003). Around the world, they found, men are more violent and more socially dominant than women are. Men are more interested in the youth and beauty of their sexual partners, presumably because youth is associated with fertility (see Figure 3.2). According to their responses on questionnaires, men are more sexually jealous and possessive, presumably because if a man's mate had sex with other men, he could never be 100% sure that her children were genetically his as well. They are quicker than women to have sex with partners they don't know well and more inclined toward polygamy and promiscuity, presumably so that their sperm will be distributed as widely as possible. Women, in contrast, tend to emphasize the financial resources or prospects of a potential mate, his status, and his willingness to commit to a relationship. On questionnaires, they say they would be more upset by a partner's emotional infidelity than by his sexual infidelity, presumably because abandonment by the partner might leave them without the support and resources needed to raise their offspring. Many studies have reported similar results (e.g., Bailey et al., 1994; Buss, 1996, 2000; Buss & Schmitt, 2011; Buunk et al., 1996; Daly & Wilson, 1983; Mealey, 2000; Sprecher, Sullivan, & Hatfield, 1994).

A basic assumption of evolutionary approaches to sexuality is that females across species have a greater involvement in child rearing than males do. But there are many exceptions. Female emperor penguins, for example, take off every winter, leaving behind males like this one to care for the young.

The Genetic Leash

Evolutionary views of sex differences have become enormously popular. Many academics and lay people are persuaded that there are indeed evolutionary advantages for males in sowing their seed far and wide and evolutionary advantages for females in finding a man with a good paycheque.

But critics, including some evolutionary theorists, have challenged this conclusion on conceptual and methodological grounds:

1 **Stereotypes versus actual behaviour.** Many critics argue that current evolutionary explanations of infidelity and monogamy are based on simplistic *stereotypes* of gender differences. The actual behaviour of humans and other animals often fails to conform to images of sexually promiscuous males and coy, choosy females (Barash & Lipton, 2001; Birkhead, 2001; Fausto-Sterling, 1997; Hrdy, 1994; Roughgarden, 2004). In many species of birds, fish, and mammals, including human beings, females are sexually ardent and often have many male partners. The female's sexual behaviour does not seem to depend only on the goal of being fertilized by the male: Females have sex when they are not ovulating and even when they are already pregnant. And in many species, from penguins to primates, males do not just mate and run. They stick around, feeding the infants, carrying them, and protecting them from predators (Hrdy, 1988; Snowdon, 1997).

Human sexual behaviour, especially, is amazingly varied and changeable across time and place. Cultures range from those in which women have many children to those in which they have very few, from those in which men are intimately involved in child rearing to those in which they take no part at all, from those in which women may have many lovers to those in which women may be killed for having sex outside of marriage (Hatfield & Rapson, 1996/2005). In many places, the chastity of a potential mate is much more important to men than to women; but in other places, it is important to both sexes—or to neither one (see Figure 3.3). In some places, just as evolutionary theory predicts, a relatively few men—those with the greatest wealth and power—have a far greater number of offspring than other men do; but in many societies, including some polygamous ones, powerful men do not have more children than men who are poor or who are low in status (Brown, Laland, & Mulder, 2009). Sexual attitudes and practices also vary tremendously within a culture, as is immediately apparent to anyone surveying the panorama of sexual attitudes and behaviours within the United States and Canada (Laumann et al., 2004; Levine, 2002).

Much of the data cited by evolutionary psychologists have come from questionnaires and interviews. In this research, when people (often undergraduates) are asked to rank the qualities they most value in a potential mate, sex differences appear, just as evolutionary theory would predict (Kenrick et al., 2001). But when we examine the evidence more closely, we find problems. For example, despite their differences, *both* sexes usually rank kindness, intelligence, and understanding over physical qualities or financial status.

2 **Convenience versus representative samples.** In Chapter 2 we saw that "convenience samples" of undergraduates sometimes produce research results that do not apply to nonstudents. This may well be the case in much of the evolutionary research on attitudes toward sex and marriage. In a recent national study, researchers at the U.S. Centers for Disease Control and Prevention (CDC) interviewed more than 12 000 men and women aged 15 to 44 about sex, living together, marriage, divorce, and parenting (Martinez et al., 2006). The agency had conducted similar surveys since 1973 but only with women. This time, the researchers *asked a question* that in retrospect seems obvious: What about men? Thus they were able to draw conclusions about male and female attitudes based on a sample that was far more representative of the general population than those used by most researchers. What they found throws a different light on evolutionary notions of sex differences.

For example, as we've seen, in the evolutionary view, women on the whole value commitment to a relationship more than men do and are more dedicated to parenting. Yet 66% of the men, compared to only 51% of the women, agreed or strongly agreed with the statement "It is better to get married than go through life being single." Further, most women *and* men agreed that "It is more important for a man to spend a lot of time with his family than be successful at his career." Among fathers in their first marriage, 90% were living with their kids and spent considerable time feeding and bathing them, helping them with homework, and taking them to activities. And 94% of both sexes agreed that "The rewards of being a parent are worth it despite the cost and work it takes."

As always, we need to avoid oversimplification. Some results did go in the stereotypical direction. More men than women (60% versus 51%) agreed that it was

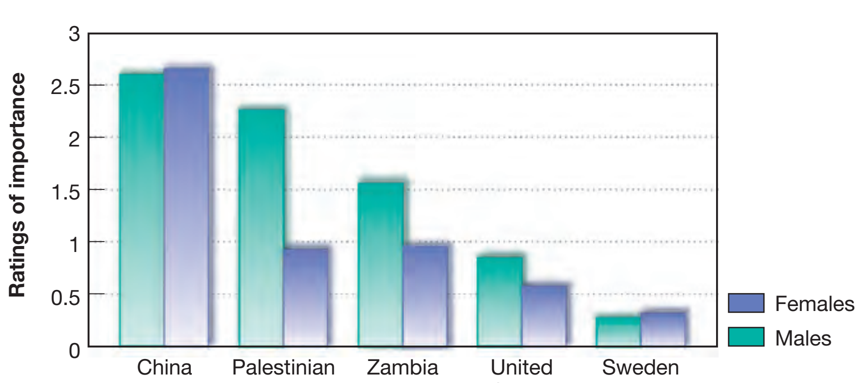


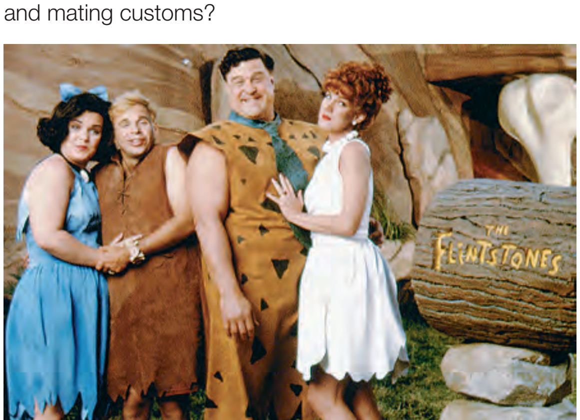
FIGURE 3.3 Attitudes toward Chastity
In many places, men care more about a partner's chastity than women do, as evolutionary psychologists would predict. But culture has a powerful impact on these attitudes, as this graph shows. Notice that in China, both sexes prefer a partner who has not yet had intercourse, whereas in Sweden, chastity is a nonissue. (From Buss, 1995.)

acceptable for unmarried 18-year-olds to have sexual relations "if they have strong affection for each other." Women were also more likely to be married by age 30 than men were. And decades of research have found that men are likely to have more premarital sexual partners than women are. But taken as a whole, the CDC findings suggest that men are just as interested in serious family relationships as women are.

3 **What people say versus what they do.** There is yet another problem in surveys inspired by evolutionary theories. Some critics have questioned an assumption underlying those surveys: that people's responses are a good guide to their actual choices and actions. When you ask people which would upset them more, their mate's having sex with someone else or their mate's falling in love with someone else, women are usually likelier than men to say that emotional infidelity would be worse (although there are big variations across cultures). But when one researcher asked people about their *actual* experiences with infidelity, men and women did not differ at all in the degree to which they had focused on the emotional or sexual aspects of their partners' behaviour (C. Harris, 2003). In fact, men, supposedly the more sexually jealous sex, were significantly more likely than women to have tolerated their partners' sexual unfaithfulness, whereas women were more likely to have ended their relationships over it. If you are thinking critically, you may be wondering whether these questionnaire results are any more reliable than those on dating preferences. Good question! The answer is yes. From studies that had people keep diaries of how they spend their time each day, we know that men's behaviour has changed along with their attitudes. Women still do more housework and child care than men do, but since the 1960s, the time men spend on housework has more than doubled, and since the 1980s the time they spend on primary child care has nearly tripled (Bianchi, Robinson, & Milkie, 2006; Wang & Bianchi, 2009).

4 **The Fred Flintstone problem.** Finally, some scientists have questioned evolutionary psychologists' emphasis on the Pleistocene age, which extended from about 2 million to about 11 000 years ago. Recent analysis of the human genome in Africans, East Asians, and Europeans suggests that during the past 10 000 to 15 000 years, natural selection has continued to influence genes associated with taste, smell, digestion, bone structure, skin colour, fertility, and even brain function (Voigt et al., 2006). Some of these changes might have begun when humans abandoned hunting and gathering in favour of agriculture, a switch that made certain genetic dispositions more adaptive and others less so. David Buller (2005), a philosopher who was captivated by evolutionary psychology until he took a closer look, concludes that "There is no reason to think that contemporary humans are, like Fred and Wilma Flintstone, just Pleistocene hunter–gatherers struggling to survive and reproduce in evolutionarily novel suburban habitats."

How large an influence does our Stone Age past have on our current courtship and mating customs?



Even if the Pleistocene period did strongly influence human mating preferences, those preferences may differ from the ones usually emphasized by evolutionary theory. Our prehistoric ancestors, unlike the undergraduates in many mate-preference studies, did not have 5000 fellow students to choose from. They lived in small bands, and if they were lucky they might get to choose between Urp and Ork, and that's about it; they could not hold out for some gorgeous babe or handsome millionaire down the road. Because there was a small range of potential partners to choose from, there would have been no need for the kinds of sexual strategies described by evolutionary theorists (Hazan & Diamond, 2000). Instead, evolution might have instilled in us a tendency to select a mate based on similarity (the person's genes, background, and age roughly match our own) and proximity (the person is around a lot). Indeed, similarity and proximity are among the strongest predictors today of the mates people actually choose, whatever they may say on questionnaires (see Chapter 12). Debate over these matters can become quite heated because of worries that evolutionary arguments will be used to justify social and political inequalities and even violent behaviour. In the past, evolutionary ideas have been used to promote **social Darwinism**, the notion that the wealthy and successful are more reproductively fit than other people. Such arguments have also led some people to conclude that men, with less investment in child rearing and more interest in status and dominance, are destined to control business and politics. More than 30 years ago, Edward Wilson (1975) certainly thought so. "Even with identical education and equal access to all professions [for both sexes]," he writes, "men are likely to continue to play a disproportionate role in political life, business, and science."

social Darwinism The notion that the wealthy and successful are more reproductively fit than other people.

Recite & Review

Recite: Yabba dabba doo! Say out loud everything you can remember about *sociobiology*, *social Darwinism*, the evolutionary view of sex differences in human mating and courtship behaviour, and the four key criticisms of that view.

Review: Next, reread this section, paying extra attention to what you didn't remember.

Now take this *Quick Quiz:*

Males and females alike have evolved to be able to answer these questions.

1. Which of the following would an evolutionary psychologist expect to be more typical of males than of females? (a) promiscuity, (b) choosiness about sexual partners, (c) concern with dominance, (d) interest in young partners, (e) emphasis on physical attractiveness of partners
2. What major issue divides evolutionary theorists and their critics in debates over courtship and mating?
3. A friend of yours, who has read some sociobiology, tells you that men will always be more sexually promiscuous than women because during evolution, the best reproductive strategy for a male primate has been to try to impregnate many females. What kind of evidence would you need in order to evaluate this claim?

Answers:

1. all but b **2.** the relative influence of biology and culture **3.** You would not want to look just for confirming evidence (recall the principle of falsifiability from Chapter 2). You would want to look also for evidence of female promiscuity and male monogamy among humans and other species and changes in human sexual customs in response to changing social conditions.

Learning Objectives

- 11 State what it means to say that a trait is "heritable."
- 12 List three important facts about heritability.
- 13 Describe how researchers estimate a trait's heritability.

The Genetics of Difference

We have been focusing on the origins of human similarities. We turn now to the second great issue in debates about nature and nurture: the origins of the differences among us. We begin with a critical discussion of what it means to say that a trait is "heritable." Then, to illustrate how behavioural geneticists study differences among people that might be influenced by genes, we will examine in detail a single, complex issue: the genetic and environmental contributions to intelligence. In other sections of this book, you will be reading about behavioural–genetic findings on many other topics, including biological rhythms (Chapter 5), taste perception (Chapter 6), weight and body shape (Chapter 12), sexual orientation (Chapter 12), personality and temperament (Chapter 14), addiction (Chapter 15), and mental disorders (Chapter 15).

The Meaning of Heritability

Suppose you want to measure flute-playing ability in a large group of music students, so you have some independent raters assign each student a score from 1 to 20. When you plot the scores, you find that some people are what you might call melodically disadvantaged and should forget about a musical career, others are flute geniuses, and the rest fall somewhere in between. What causes the variation in this group of students? Why are some so musically talented and others so inept? Are these differences primarily genetic, or are they the result of experience and motivation?

THINKING CRITICALLY

Define Your Terms

What does it mean to say that some trait is highly heritable? If you want to improve your flute playing and someone tells you that musical ability is heritable, should you stop practising?

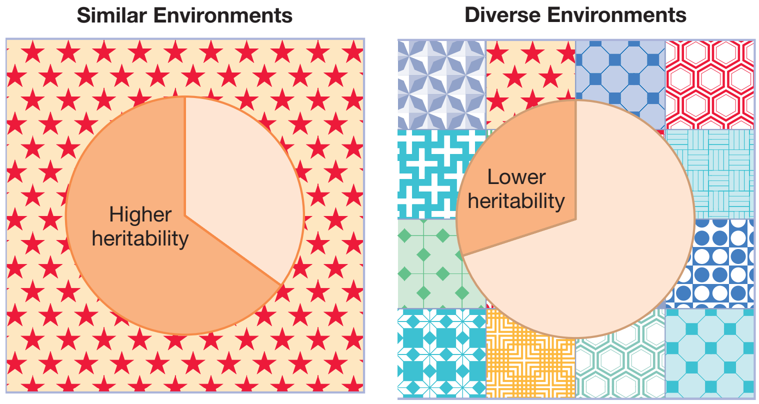
To answer such questions, behavioural geneticists compute a statistic called **heritability**, which gives an estimate of the *proportion of the total variance in a trait that is attributable to genetic variation within a group*. Because the heritability of a trait is expressed as a proportion (such as 0.60, or 60/100), the maximum value it can have is 1.00 (equivalent to "100% of the variance"). Height is highly heritable; that is, within a group of equally well-nourished individuals, most of the variation among them will be accounted for by their genetic differences. In contrast, table manners have low heritability because most variation among individuals is accounted for by differences in upbringing. Our guess is that flute-playing ability—and musical ability in general—falls somewhere in the middle. Differences in the ability to correctly perceive musical pitch and melody appear to be highly heritable; some people, it seems, really are born with a "tin ear" (Drayna et al., 2001). Nonetheless, musical training can enhance normal musical ability, and lack of musical training can keep a person with normal ability from tuning in to the nuances of music.

Watch the **Video** *The Basics: Genetic Mechanisms and Behavioural Genetics* in **MyPsychLab**

Many people hold completely mistaken ideas about heritability. But as genetic findings pour in, the public will need to understand this concept more than ever. You cannot understand the nature–nurture issue without understanding the following important facts about heritability:

1 **An estimate of heritability applies only to a particular group living in a particular environment.** Heritability may be high in one group and low in another. Suppose that all the children in community A are affluent, eat plenty of high-quality food, have kind and attentive parents, and go to the same top-notch schools. Because their environments are similar, any intellectual differences among them will have to be due largely to their genetic differences. In other words, mental ability in this group will be highly heritable. In contrast, suppose the children in community B are rich, poor, and in between. Some of them have healthy diets; others live on fatty foods and cupcakes. Some attend good schools; others go to inadequate ones. Some have doting parents, and some have unloving and neglectful ones. These children's intellectual differences could be due to their environmental differences and, if that is so, the heritability of intelligence for this group will be low. Indeed, in a study that followed 48 000 American children from birth to age seven, intelligence did depend greatly on socioeconomic status. In impoverished families, 60% of the variance in IQ was accounted for by environmental factors shared by family members, and the contribution of genes was close to zero. In affluent families, the result was nearly exactly the reverse: Heritability was extremely high, and shared environment contributed hardly at all (Turkheimer et al., 2003).

heritability A statistical estimate of the proportion of the total variance in some trait that is attributable to genetic differences among individuals within a group.



2 **Heritability estimates do not apply to individuals, only to variations within a group.** You inherited half your genes from your mother and half from your father, but your *combination* of genes has never been seen before and will never be seen again (unless you have an identical twin). You also have a unique history of family relationships, intellectual training, and life experiences. It is impossible to know just how your genes and your personal history have interacted to produce the person you are today. For example, if you are a great flute player, no one can say whether your ability is mainly a result of inherited musical talent, living all your life in a family of devoted flute players, a private obsession that you acquired at age six when you saw the opera *The Magic Flute*—or a combination of all three. For one person, genes may make a tremendous difference in some aptitude or disposition; for another, the environment may be far more important. Scientists can study only the extent to which differences among people in general are explained by their genetic differences.

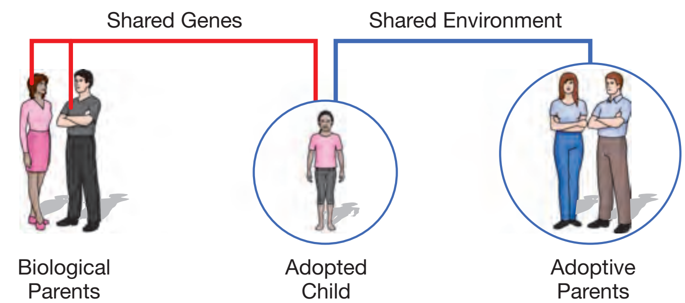
3 **Even highly heritable traits can be modified by the environment.** Although height is highly heritable, malnourished children may not grow to be as tall as they would with sufficient food, and children who eat an extremely nutritious diet may grow to be taller than anyone thought they could. Hair colour is genetically determined, but a trip to a hair stylist can transform you from a brunette to a blonde, or vice versa. The same principle applies to psychological traits, although biological determinists sometimes fail to realize this. They argue, for example, that because IQ is highly heritable, IQ and school achievement cannot be boosted much (Herrnstein & Murray, 1994; Murray, 2008). But even if the first part of the statement is true, the second part does not necessarily follow, as we will see.

For instance, most of us have five fingers on each hand, something that is specified in our genetic recipe. If we went out and looked for people who didn't have five fingers per hand—say, those who had four fingers—we would probably conclude that genes had nothing to do with the number of fingers people have. We would find that most people with fewer than five fingers on each hand have lost digits as the result of accidents. This does not mean that their genes did not influence the number of fingers they were born with—just that the environment modified this heritable trait (Ridley, 2000).

Computing Heritability

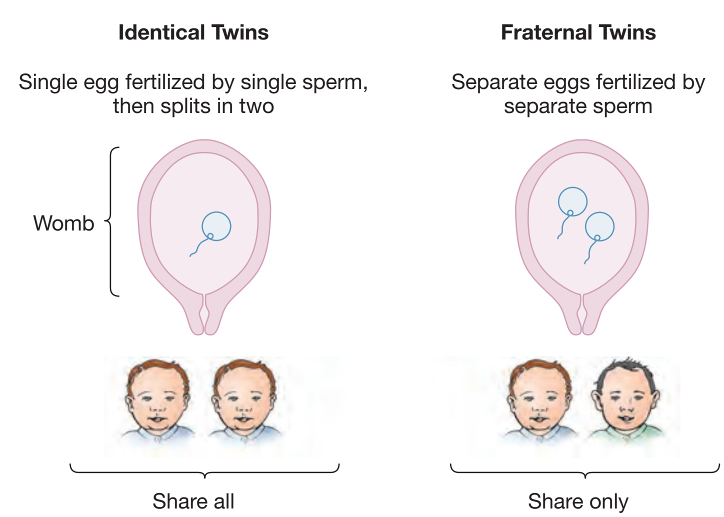
Scientists have no way to estimate the heritability of a trait or behaviour directly, so they must *infer* it by studying people whose degree of genetic similarity is known. You might think that the simplest approach would be to compare biological relatives within families; everyone knows about families that are famous for some talent or trait. But family traits do not tell us much because close relatives usually share environments as well as genes. If Carlo's parents and siblings all love lasagna, that does not mean a taste for lasagna is heritable! The same applies if everyone in Carlo's family has a high IQ, is mentally ill, or is moody.

A better approach is to study adopted children (e.g., Loehlin, Horn, & Willerman, 1996; Plomin & DeFries, 1985). Such children share half their genes with each birth parent, but they grow up in a different environment, apart from their birth parents. On the other hand, they share an environment with their adoptive parents and siblings but not their genes:



Researchers can compare correlations between the traits of adopted children and those of their biological and adoptive relatives and can use the results to compute an estimate of heritability.

Another approach is to compare identical twins with fraternal twins. **Identical (monozygotic) twins** develop when a fertilized egg (zygote) divides into two parts that then develop as two separate embryos. Because the twins come from the same fertilized egg, they share all their genes. Some surprising recent work, however, suggests that duplicated or missing blocks of DNA (sets of those As, Cs, Gs, and Ts that we discussed earlier) can exist in one identical twin but not the other (Bruder et al., 2008). Also, prenatal accidents or illnesses can modify the genetic expression in only one twin (Plomin, 2011). (Identical twins may be slightly different at birth, however, because of differences in the blood supply to the two fetuses or other chance factors.) In contrast, **fraternal (dizygotic) twins** develop when a woman's ovaries release two eggs instead of one and each egg is fertilized by a different sperm. Fraternal twins are womb mates, but they are no more alike genetically than any other two siblings (they share, on average, only half their genes), and they may be of different sexes:



identical (monozygotic) twins Twins that develop when a fertilized egg divides into two parts that develop into separate embryos.

fraternal (dizygotic) twins Twins that develop from two separate eggs fertilized by different sperm; they are no more alike genetically than are any other pair of siblings.

Behavioural geneticists can estimate the heritability of a trait by comparing groups of same-sex fraternal twins with groups of identical twins. The assumption is that if identical twins are more alike than fraternal twins, then the increased similarity must be due to genetic influences. Perhaps, however, identical twins are treated differently than fraternal twins. To avoid this problem, investigators have studied identical twins who were separated early in life and reared apart. (Until recently, adoption policies and attitudes toward births out of wedlock permitted such separations to occur.) In theory, separated identical twins share all their genes but not their environments. Any similarities between them should be primarily genetic and should permit a direct estimate of heritability.

Recite & Review

Recite: Say out loud everything you can recall about *heritability*, and ways of inferring or computing it, *identical (monozygotic) twins*, and *fraternal (dizygotic) twins*.

Review: Treat this review identically to all others, and reread this section to see what you might have overlooked.

Now take this *Quick Quiz:*

1. Diane hears that basket-weaving ability is highly heritable. She assumes that her own low performance must therefore be due mostly to genes. What is wrong with her reasoning?
2. Bertram hears that basket-weaving ability is highly heritable. He concludes that schools should not bother trying to improve the skills of children who lack this talent. What is wrong with his reasoning?
3. Basket-weaving skills seem to run in Andy's family. Why shouldn't Andy conclude that his own talent is genetic?
4. Why do behavioural geneticists find it useful to study twins?

Answers:

1. Heritability applies only to differences among individuals within a group, not to particular individuals. **2.** A trait may be highly heritable and still be susceptible to modification. **3.** Family members share not just genes but also environments. **4.** Identical twins growing up together share an environment, and so do fraternal twins. So if identical twins are more alike than fraternal twins, then the increased similarity is assumed to be genetic. Identical twins reared apart share only their genes, not their environment, so similarities between them should be primarily genetic also.

Learning Objectives

14 Describe the extent to which intelligence may be heritable.

15 Identify a common error in the argument that one group is genetically smarter than another.

16 List how the environment nurtures or thwarts mental ability.

Our Human Diversity: The Case of Intelligence

Behavioural-genetics research has transformed our understanding of many aspects of behaviour that were once explained solely in psychological terms. Some findings, such as the discovery that certain mental illnesses have a genetic component, have been accepted readily. Other findings, however, have inflamed political passions and upset people. No topic has aroused more controversy than the origins of human intelligence.

intelligence quotient (IQ) A measure of intelligence originally computed by dividing a person's mental age by his or her chronological age and multiplying by 100; it is now derived from norms provided for standardized intelligence tests.

Genes and Individual Differences

In heritability studies, the usual measure of intellectual functioning is an **intelligence quotient (IQ)** score. Scores on an IQ test reflect how a child has performed compared with other children of the same age, or how an adult has performed compared with other adults. The average score for each age group is arbitrarily set at 100. The distribution of scores in the population approximates a normal (bell-shaped) curve, where scores near the average (mean) are the most common and very high or very low scores are rare. Two-thirds of all test-takers score between 85 and 115.

Most psychologists believe that IQ tests measure a general quality that affects most aspects of mental ability, but the tests also have many critics. Some argue that intelligence comes in many varieties, more than are captured by a single score. Others argue that IQ tests are culturally biased, tapping mostly those abilities that depend on experiences in a middle-class environment and favouring white people over people of other ethnicities. We discuss the measurement of intelligence and debates surrounding this concept more fully in Chapter 9. For now, keep in mind that most heritability estimates apply only to those mental skills that affect IQ test scores and that these estimates are likely to be more valid for some groups than for others. You cannot use a heritability estimate from one group of people and apply it to another, different group of people.

Despite these important qualifications, it is clear that the kind of intelligence that produces high IQ scores is highly heritable, at least in the middle-class samples usually studied. For children and adolescents, heritability estimates average around 0.40 or 0.50; that is, about half of the variance in IQ scores is explainable by genetic differences (Chipuer, Rovine, & Plomin, 1990; Devlin, Daniels, & Roeder, 1997; Plomin, 1989). For adults, the estimates until late middle age are even higher—in the 0.60 to 0.80 range (Bouchard, 1995; McClearn et al., 1997; McGue et al., 1993). That is, the genetic contribution becomes relatively larger and the environmental one relatively smaller with age. Some psychologists, however, note that most people who adopt children are screened to make sure they have a secure income, are psychologically stable, and so forth. As a result, critics argue, there is not much "variation" in adopted children's environments, which spuriously inflates the variation due to heredity (Nisbett, 2009). In studies of twins, the scores of identical twins are always much more highly correlated than those of fraternal twins, a difference that reflects the influence of genes. In fact, the scores of identical twins reared *apart* are more highly correlated than those of fraternal twins reared *together*, as you can see in Figure 3.4. In adoption studies, the scores of adopted children are more highly correlated with those of their birth parents than with those of their biologically unrelated adoptive parents; the higher the birth

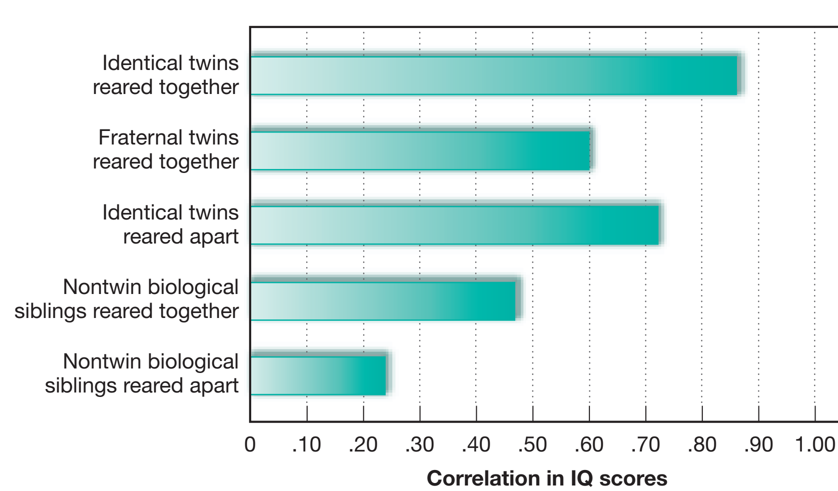


FIGURE 3.4 Correlations in Siblings' IQ Scores
The IQ scores of identical twins are highly correlated, even when they are reared apart. The figures represented in this graph are based on average correlations across many studies (Bouchard & McGue, 1981).

parents' scores, the higher the child's score is likely to be. As adopted children grow into adolescence, the correlation between their IQ scores and those of their biologically unrelated family members diminishes, and in adulthood the correlation falls to *zero* (Bouchard, 1997b; Scarr, 1993; Scarr & Weinberg, 1994). (This does not mean that adoption has no positive effects; adopted children score higher on IQ tests than do birth siblings who were not adopted, probably because adoptees grow up in more enriched environments [van Ijzendoorn et al., 2005].)

The Question of Group Differences

If genes influence individual differences in intelligence, do they also help account for differences between groups, as many people assume? Unfortunately, the history of this issue has been marred by ethnic, class, and gender prejudice. As Stephen Jay Gould (1996) notes, genetic research has often been bent to support the belief that some groups are destined by "the harsh dictates of nature" to be subordinate to others. Because this issue has enormous political and social importance, we are going to examine it closely.

Most of the focus has been on black–white differences in IQ, because black children score, on average, some 10 to 12 points lower than do white children. (We are talking about averages; the distributions of scores for black children and white children overlap considerably.) A few psychologists have proposed a genetic explanation of this difference (Jensen, 1969, 1981; Rushton, 1988). As you can imagine, this topic is not merely academic. Racists have used theories of genetic differences between groups to justify their own hatreds, and politicians have used them to argue for cuts in programs that would benefit blacks, other minorities, and poor children. Some researchers themselves have concluded that there is little point in spending money on programs that try to raise the IQs of low-scoring children, of whatever race (Murray, 2008; Rushton & Jensen, 2005; Herrnstein & Murray, 1994).

THINKING CRITICALLY

Analyze Assumptions and Biases

Most behavioural-genetics studies show the heritability of intelligence to be high. A popular book argues that heredity must play a similarly large role in average IQ differences between ethnic groups. What's wrong with the assumption behind that reasoning?

Genetic explanations, however, have a fatal flaw: They use heritability estimates based mainly on samples of white people to estimate the role of heredity in *group* differences, a procedure that is not valid. This problem sounds pretty technical, but it is really not too difficult to understand, so stay with us.

Consider, first, not people, but tomatoes. (Figure 3.5 will help you visualize the following "thought experiment.") Suppose you have a bag of tomato seeds that vary genetically; all things being equal, some will produce tomatoes that are puny and tasteless, and some will produce tomatoes that are plump and delicious. Now you take a bunch of these seeds in your left hand and another bunch from the same bag in your right hand. Though one seed differs genetically from another, there is no *average* difference between the seeds in your left hand and those in your right. You plant the left hand's seeds in pot A, with some enriched soil that you have doctored with nitrogen and other nutrients, and you plant the right hand's seeds in pot B, with soil from which you have extracted nutrients. You sing to pot A and put it in the sun; you ignore pot B and leave it in a dark corner.

When the tomato plants grow, they will vary *within* each pot in terms of height, the number of tomatoes produced, and the size of the tomatoes, purely because of genetic differences. But there will also be an average difference between the plants in pot A and those in pot B: The plants in pot A will be healthier and bear more tomatoes. This difference *between* pots is owing entirely to the different soils and the care that has been given to them—even though the heritability of the *within*-pot differences is 100% (Lewontin, 1970). The same is true for real plants, by the way; if you take identical, cloned plants and grow them at different elevations, they will develop differently (Lewontin, 2001).

FIGURE 3.5 The Tomato Plant Experiment
In the hypothetical experiment described in the text, even if the differences among plants within each pot were due entirely to genetics, the average differences between pots could be environmental. The same general principle applies to individual and group differences among human beings.

The principle is the same for people as it is for tomatoes. Although intellectual differences *within* groups are at least partly genetic in origin, that does not mean differences *between* groups are genetic. Blacks and whites do not grow up, on the average, in the same "pots" (environments). Because of a long legacy of racial discrimination and de facto segregation, black children, as well as other minority children, often receive far fewer nutrients—literally, in terms of food, and figuratively, in terms of education, encouragement by society, and intellectual opportunities (Nisbett, 2009). Ethnic groups also differ in countless cultural ways that affect their performance on IQ tests. And negative stereotypes about ethnic groups may cause members of these groups to doubt their own abilities, become anxious and self-conscious, and perform more poorly than they otherwise would on tests (see Chapter 9).

Doing good research on the origins of group differences in IQ is extremely difficult in the United States, where racism affects the lives of even affluent, successful black people. However, the few studies that have overcome past methodological problems fail to reveal any genetic differences between blacks and whites in whatever it is that IQ tests measure. One study found that children fathered by black and white American soldiers in Germany after the Second World War and reared in similar German communities by similar families did not differ significantly in IQ (Eyferth, 1961). Another showed that, contrary to what a genetic theory would predict, degree of African ancestry (which can be roughly estimated from skin colour, blood analysis, and genealogy) is not related to measured intelligence (Scarr et al., 1977). And white and black infants do equally well on a test that measures their preference for novel stimuli, a predictor of later IQ scores (Fagan, 1992).

Even among groups popularly thought to be high achievers, purely genetic explanations are unsatisfactory. For instance, although descendants of the Ashkenazi Jews of Europe tend to have higher IQ scores than their non-Jewish white counterparts, their accomplishments exceed what would be expected on the basis of their IQ scores alone (Nisbett et al., 2012). An intelligent reading of the research on intelligence, therefore, does not direct us to conclude that differences among cultural, ethnic, or national groups are permanent, genetically determined, or a sign of any group's innate superiority. On the contrary, the research suggests that we should make sure that all children grow up in the best possible soil, with room for the smartest and the slowest to find a place in the sun.

The Environment and Intelligence

By now you may be wondering what kinds of experiences hinder intellectual development and what kinds of environmental "nutrients" promote it. Here are some of the influences associated with reduced mental ability:

- ***Poor prenatal care.*** If a pregnant woman is malnourished, contracts infections, takes certain drugs, smokes, is exposed to secondhand smoke, or drinks alcohol regularly, her child is at risk of having learning disabilities and a lower IQ.
- ***Malnutrition.*** The average IQ gap between severely malnourished and well-nourished children can be as high as 20 points (Stoch & Smythe, 1963; Winick, Meyer, & Harris, 1975).
- ***Exposure to toxins.*** Lead, especially, can damage the nervous system, even at fairly low levels, producing attention problems, lower IQ scores, and poorer school achievement (Hornung, Lanphear, & Dietrich, 2009; Lanphear et al., 2005; Needleman et al., 1996). Many children in the United States are exposed to dangerous levels of lead from dust, contaminated soil, lead paint, and old lead pipes, and the concentration of lead in black children's blood is 50% higher than in white children's (Lanphear et al., 2002). Air pollution, which people cannot control

directly, also appears to be a serious risk factor. A recent longitudinal study of nonsmoking inner-city women found a link between delayed cognitive development in the women's children and the level of pollutants from fossil fuels that the mothers were exposed to during pregnancy. The culprit appears to be a chemical spewed from vehicles and power plants. Even after controlling for other factors, such as lead exposure, the researchers found that by age three, the children of highly exposed mothers were more than twice as likely as other children to be developmentally delayed (Perera et al., 2006). As well, children exposed in utero to high levels of pesticides (still legal for spraying on farm fields) later have an IQ that is 7 points lower than children with the least exposure (Raloff, 2011).

Severe poverty, exposure to toxic materials, run-down neighbourhoods, and stressful family circumstances can all have a negative impact on children's cognitive development and IQ.

- ***Stressful family circumstances.*** Factors that predict reduced intellectual competence include, among others, having a father who does not live with the family, a mother with a history of mental illness, parents with limited work skills, and a history of stressful events, such as domestic violence, early in life (Sameroff et al., 1987). On average, each risk factor reduces a child's IQ score by 4 points. Children with seven risk factors score more than *30 points lower* than those with no risk factors. And when children live in severely disadvantaged neighbourhoods, their verbal IQs decline over time, even after they have moved to better areas; the drop is comparable to that seen when a child misses a year of school (Sampson, Sharkey, & Raudenbush, 2008).

In contrast, a healthy and stimulating environment can raise mental performance (Guralnick, 1997; Nelson, Westhues, & MacLeod, 2003; Ramey & Ramey, 1998). Attending quality preschool increases the reading and math skills of children from racial and ethnic minorities, especially if they are not getting much cognitive stimulation elsewhere (Tucker-Drob, 2012). In one longitudinal study called the Abecedarian Project, inner-city children who received lots of mental enrichment at home and in child care or school, starting at infancy, had much better school achievement than did children in a control group (Campbell & Ramey, 1995). In another important study, of abandoned children living in Romanian orphanages, researchers randomly assigned some children to remain in the orphanages and others to move to good foster homes. By age four, the fostered children scored dramatically higher on IQ tests than did those left behind. Children who moved before age two showed the largest gains, almost 15 points on average. A comparison group of children reared in their biological homes did even better, with average test scores 10 to 20 points higher than those of the foster children (Nelson et al., 2007). (Since this study was done, Romania has stopped institutionalizing abandoned children younger than two unless they are seriously disabled.)

Although no single activity is going to turn anyone into a genius, certain experiences do appear to contribute to overall intelligence. In general, children's mental abilities improve when their parents talk to them about many topics and describe things accurately and fully, encourage them to think things through, read to them, and expect them to do well. A child's abilities also improve when the child's peers value and strive for intellectual achievement (Harris, 2009). Some kinds of enrichment classes may also help. When Canadian researchers randomly assigned grade 1 students to weekly piano, singing, or drama lessons during the school year, or to a

The children of migrant workers (left) often spend long hours doing backbreaking field work and may miss out on the educational opportunities and intellectual advantages available to middle-class children (right).

control group that received no extracurricular lessons, those children who learned to play the piano or sing showed an average IQ increase of 7 points by the end of the school year—compared to 4.3 points in the other groups. This difference was not large, but it was statistically significant (Schellenberg, 2004). The music lessons might have helped the children pay attention, use their memories, and hone their fine-motor skills, thus contributing to the development of brain areas involved in intelligence.

Perhaps the best evidence for the importance of environmental influences on intelligence is the fact that IQ scores in developed countries have been climbing steadily for at least three generations (Flynn, 1987, 1999) (see Figure 3.6). A similar increase has been documented in Kenya, a developing country: Rural children aged six to eight scored about 11 points higher in 1998 than their peers did in 1984—the fastest rise in a group's average IQ scores ever reported (Daley et al., 2003). Genes cannot possibly have changed enough to account for these findings. Most psychologists attribute the increases to improvements in education, the growth in jobs requiring abstract thought, and better nutrition and health (Neisser, 1998).

We see, then, that although heredity may provide the range of a child's intellectual potential—a Homer Simpson can never become an Einstein—many other factors affect where in that range the child will fall.

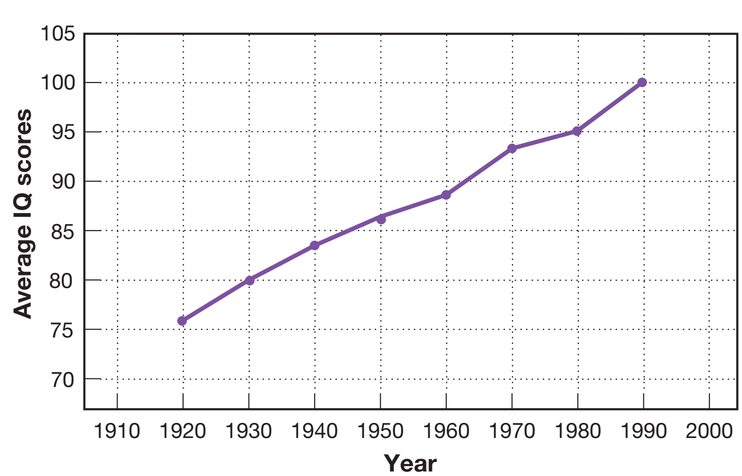


FIGURE 3.6 Climbing IQ Scores
Raw scores on IQ tests have been rising in developed countries for many decades at a rate much too steep to be accounted for by genetic changes. Because test norms are periodically readjusted to set the average score at 100, most people are unaware of the increase. On this graph, average scores are calibrated according to 1989 norms. As you can see, performance was much lower in 1918 than in 1989. (Adapted from Horgan, 1995.)

Recite & Review

Recite: Say out loud everything you can recall about *IQ*, the heritability of IQ, group differences in IQ, and environmental influences on IQ and mental abilities.

Review: There was some complicated information in this section, so reread it carefully.

Now take this *Quick Quiz:*

Are you thinking intelligently about intelligence?

1. On average, behavioural-genetics studies estimate the heritability of intelligence to be (a) about 0.90, (b) about 0.20, (c) low at all ages, (d) higher for adults than for children.
2. *True or false:* If a trait such as intelligence is highly heritable within a group, then differences between groups must also be due mainly to heredity.
3. The available evidence (does/does not) show that ethnic differences in average IQ scores are due to genetic differences.
4. Name four environmental factors associated with reduced mental ability.

Answers:

1. d **2.** false **3.** does not **4.** poor prenatal care, malnutrition, exposure to toxins, and stressful family circumstances

Beyond Nature versus Nurture

This chapter opened with two questions: What makes us alike as human beings, and why do we differ? Today, a prevalent but greatly oversimplified answer is: It's all genetic. Genes, it's claimed, make men sexually adventurous and women sexually choosy. You either have a gene for smartness, musical ability, math genius, or friendliness, or you don't. In this climate, many people who believe in the importance of learning, opportunities, and experience feel that they must take an equally oversimplified position: Genes, they say, don't matter at all. As new findings in genetics emerge, scientists are finding that this interaction is even more complex than anyone imagined just a few years ago (Barry, 2007). This is not a text book on genetics, but we think you should know about a few developments in the field that promise to radically alter our understanding of nature and nurture in the coming years.

THINKING CRITICALLY

Tolerate Uncertainty

Many people would like to specify precisely how much genes and the environment independently contribute to human qualities. But is this goal achievable? Is a human being like a jigsaw puzzle made up of separate components, or more like a cake with blended ingredients that interact to produce its unique taste?

To begin with, scientists are revisiting the whole notion of what a gene is. It turns out that some individual genes may be fragmented and intertwined with other genes, making the search for genes associated with any particular trait or condition even more difficult. Scientists are also rethinking their ideas about noncoding DNA, the DNA that is found outside of genes and that until recently was disparagingly referred to as "junk DNA." Mutations in this DNA could possibly be associated with common diseases. Messages from noncoding DNA, along with random chemical events in cells, may also affect the "expression" (activity) of certain genes.

As we have seen, however, heredity and environment always interact to produce the unique mixture of qualities that make up a human being. At the start of this chapter, we mentioned that genes switch on or off depending on the experiences a person has and on the activity of other genes. Gene expression also varies because of random biochemical processes within bodily cells, which geneticists call "noise." As a result of these extraordinary developments, a specialty called **epigenetics** has emerged to study changes in gene expression due to mechanisms other than structural changes in the DNA itself. In part because of epigenetic influences, identical twins and even cloned,

epigenetics The study of changes in gene expression due to mechanisms other than structural changes in DNA.

Genes are not destiny. In fact, because of "noise" and other influences on gene expression, even identical twins and cloned animals are not exactly alike. The first cat ever cloned (left) was named CC, for "carbon copy," but she's not really a carbon copy of her genetically identical mother. The two have different coat patterns and different personalities.

genetically identical animals living in exactly the same environment can differ considerably in appearance and behaviour (Raser & O'Shea, 2005). Yes, you read that right: Even clones can differ (as fans of *Battlestar Galactica* already know). The study of epigenetics is demonstrating that the timing and pattern of genetic activity are critical not only before birth but throughout life (Feinberg, 2008). This means that the genome is not a static blueprint for development but more like a constantly changing network of interlinked influences, including environmental ones. Even more astonishing, work with animals finds that at least some epigenetic changes can be transmitted to the next generation (Champagne, 2009).

Thus we can no more speak of genes, or of the environment, "causing" personality or intelligence in a straightforward way than we can speak of butter, sugar, or flour individually causing the taste of a cake (Lewontin, Rose, & Kamin, 1984). Many people do speak that way, however, out of a desire to make things clearer than they actually are, and sometimes to justify prejudices about ethnicity, gender, or class.

An unstated assumption in many debates about nature and nurture is that the world would be a better place if certain kinds of genes prevailed. This assumption overlooks the fact that nature loves genetic diversity, not similarity. The ability of any species to survive depends on such diversity. If every penguin, porpoise, or person had exactly the same genetic strengths and weaknesses, these species could not survive changes in the environment; a new virus or a change in climate would wipe out the entire group. With diversity, at least some penguins, porpoises, or people have a chance of making it.

Psychological diversity is adaptive, too. Each of us has something valuable to contribute, whether it is artistic talent, academic ability, creativity, social skill, athletic prowess, a sense of humour, mechanical aptitude, practical wisdom, a social conscience, or the energy to get things done. In our complicated, fast-moving world, all these qualities are needed. The challenge, for any society, is to promote the potential of each of its members.

Taking Psychology with You

THINKING CRITICALLY IN EVERYDAY LIFE

Should You Have Genetic Testing?

Imagine that you have been feeling depressed and you go to a clinical psychologist for help.

The psychologist interviews you, gives you a battery of psychological tests, lets you talk about your problems—and then has your blood drawn to check your DNA, to find out if you have a genetic predisposition for depression.

The psychologist has your blood drawn? Right now, this scenario is purely hypothetical, but perhaps not for long. Two leading experts in behavioural genetics, Robert Plomin and John Crabbe (2000), have predicted that in the not-so-distant future, therapists will routinely have their clients' DNA tested to gather information for use in diagnosis and treatment. This is already possible, they note, for Alzheimer's disease: Having a DNA marker for a gene that codes for a particular protein heightens an individual's risk of developing the disease. Would you want to be tested for a gene that increases the risk of developing Alzheimer's? How would you feel about being tested for a gene that increases the risk of an early death? Would you want to know so that you could plan accordingly, or would you rather let the chips fall where they may? Pregnant women and their partners are often tested to determine whether they are carrying genes that are likely to condemn their children to a fatal or painful disease. When the test results are positive, many choose to abort the pregnancies. But what if you could be tested for a gene that increases your future child's risk of developing a mental or emotional disorder, such as schizophrenia or autism? Would you want to have that sort of test, and what would you do with the results? What if the test were for a more common condition, such as a reading disability or obesity? And what if the condition were homosexuality, which is not a disorder at all but which some people fear; or being very short, which in some quarters is a social disadvantage but is hardly a disability? If prenatal genetic testing revealed that your child had a somewhat increased chance of being gay or short, what would you do with that information? Would you consider aborting the fetus?

In coming years, as noninvasive methods of genetic testing such as blood tests are introduced and become widespread, all of us are going to have to think long and hard about such questions. You can use information from this chapter to evaluate the pros and cons of such testing for yourself or a family member. Here are some things to keep in mind:

Genes are not destiny. It is true that some diseases, such as Huntington's, are caused by a single gene. However, as we have seen, most traits are influenced by many genes, by environmental factors, and by biochemical and other events within cells. That is why knowing that you have markers for one or two genes that may contribute to a trait or disorder does not necessarily tell you much in practical terms.

Knowing about a genetic disposition can create a premature diagnosis or a self-fulfilling prophecy. If parents and school officials know that a child is at risk of developing a learning disorder, they may treat the child as cognitively impaired even though the child has not shown any signs of a problem. If a person is aware of having a genetic predisposition toward depression, he or she may not develop the skills to cope with setbacks, deciding incorrectly that "there's nothing I can do."

Genes do not absolve you of responsibility. Some judges are allowing or even compelling defendants in criminal cases to be genetically tested for mental conditions or behavioural tendencies in order to help determine the extent of their responsibility for the crime or likelihood of repeating it (Hoffmann & Rothenberg, 2005). But "my genes made me do it" is not necessarily a good excuse for bad behaviour. Not only does the environment play a large role in behaviour, but also the flexible human brain allows us to do an end run around many of our genetic tendencies by modifying them, ignoring them, or controlling them. As David Barash (2001), an evolutionary psychologist, put it, a strong case can be made that "we are never so human as when we behave contrary to our natural inclinations, those most in tune with our biological impulses."

Genetic information could be used to discriminate against individuals. Critics of genetic testing worry that insurance companies will refuse coverage to adults and children who are currently healthy but whose DNA reveals them to have some genetic predisposition for developing a physical or psychological disorder later in life. Employers who pay insurance premiums for their workers might be reluctant to hire such individuals. So far, such cases of genetic discrimination have been rare. But some bioethicists and scholars are concerned that current laws may not adequately protect people's right to keep genetic information private.

Knowing your genetic risk does not necessarily tell you what to do about it. If your child has a physical disorder called phenylketonuria (PKU), which prevents the body from assimilating protein and causes mental retardation, the solution is obvious: Limit the intake of protein. But in the case of behavioural, cognitive, or emotional problems, the answer is usually not so straightforward. Often we simply don't yet know how to treat problems that have a genetic component, or many possible approaches exist and we don't know which one is best.

Genetic testing can be liberating or stigmatizing. Knowing that a condition or trait is "not your fault" may help you live with it or accept the limitations it imposes. For example, knowing that your child's autism is genetic and not caused by bad parenting will keep you from feeling unnecessary guilt. On the other hand, genetic testing can activate prejudices against anyone with less-than-ideal looks or abilities.

In the past, such prejudices led to the discredited social movement called *eugenics*, which aimed to "improve" the species through forced sterilization of low-IQ people. As a result, from the beginning of the twentieth century until the mid-1960s, thousands of mentally ill and developmentally delayed North Americans were sterilized against their will (Bruinius, 2006).

Defenders of genetic testing answer that the goal of prenatal screening is not to improve the human species; it is to relieve the suffering of parents and children, and therefore prospective parents should not feel guilty for taking advantage of this technology (Cowan, 2008). But to some social critics, prenatal testing for run-of-the-mill human qualities reflects a view of children as products to be perfected instead of as individuals to be appreciated for who they are (Sandel, 2007).

If abortion would be an option for you, how serious and how likely would an inherited condition have to be before you would consider aborting a fetus? Would a 10% likelihood be enough, or 50%, or would you require near certainty? Would you want to know, while you are still young, that you carry genes associated with some disorder that usually doesn't strike until middle or old age? How might this information change your life?

Summary

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Unlocking the Secrets of Genes

- In general, *evolutionary psychologists* study our commonalities and *behavioural geneticists* study our differences. Historically, *nativists* have emphasized "nature" and *empiricists* "nurture," but scientists today understand that heredity and environment interact to produce our psychological traits and even most of our physical ones. This interaction works in both directions: Genes affect the environments we choose, and the environment affects the activity of genes over our lifetimes.
- *Genes*, the basic units of heredity, are located on *chromosomes*, which consist of strands of *DNA*. Within each gene, a sequence of four elements of DNA constitutes a chemical code that helps determine the synthesis of a particular protein. In turn, proteins affect virtually all the structural and biochemical characteristics of the organism.
- Most human traits depend on more than one gene pair, which makes tracking down the genetic contributions to a trait extremely difficult. One method for doing so involves the use of *linkage studies*, which look for patterns of inheritance of the *genetic markers* whose locations on the genes are already known.
- Researchers have completed a map of the entire human *genome*. However, this map does not automatically tell us what a particular gene does or how it does so, or how multiple genes interact and influence behaviour.

The Genetics of Similarity

- Evolutionary psychologists argue that many fundamental human similarities can be traced to the processes of *evolution*, especially *natural selection*. They draw inferences about the behavioural tendencies that might have been selected because they helped our forebears solve survival problems and enhanced reproductive fitness; they then conduct research to see if such tendencies actually exist throughout the world.
- Many evolutionary psychologists believe that the mind is not a general-purpose computer, but instead evolved as a collection of specialized *mental modules* to handle specific survival problems. Among the candidates for such modules are inborn reflexes, an attraction to novelty, a motive to explore and manipulate objects, an impulse to play, and the capacity for certain basic cognitive skills, including a rudimentary understanding of number. However, because some behaviour or trait exists does not necessarily mean that it is adaptive or the product of natural selection.

Our Human Heritage: Courtship and Mating

- *Sociobiologists* and evolutionary psychologists argue that males and females have evolved different sexual and courtship strategies in response to survival problems faced in the distant past. In this view, it has been adaptive for males to be promiscuous, to be attracted to young partners, and to want sexual novelty, and for females to be monogamous, to be choosy about partners, and to prefer security to novelty.
- Critics argue that evolutionary explanations of infidelity and monogamy are based on simplistic stereotypes of gender differences; that they rely too heavily on answers to questionnaires, which often do not reflect real-life choices; that convenience samples used in questionnaire studies are not necessarily representative of people in general; and that the evolutionary emphasis on the Pleistocene Age may not be warranted. Moreover, our ancestors probably did not have a wide range of partners to choose from; what may have evolved is mate selection based on similarity and proximity. The central issue dividing evolutionary theorists and their critics is the length of the "genetic leash."

The Genetics of Difference

- Behavioural geneticists often study differences among individuals by using data from studies of adopted children and of *identical* and *fraternal twins*. These data yield an estimate of the *heritability* of traits and abilities—the extent to which differences in a trait or ability within a group of individuals is accounted for by genetic differences.
- Heritability estimates do not apply to specific individuals or to differences between groups. They apply only to differences within a particular group living in a particular environment; for example, heritability is higher for children in affluent families than in impoverished ones. Moreover, even highly heritable traits can often be modified by the environment.

Our Human Diversity: The Case of Intelligence

- Heritability estimates for intelligence (as measured by IQ tests) average about 0.40 to 0.50 for children and adolescents and 0.60 to 0.80 for adults. Identical twins are more similar in IQ test performance than fraternal twins, and adopted children's scores correlate more highly with those of their biological parents than with those of their nonbiological relatives. These results do not mean that genes determine intelligence; the remaining variance in IQ scores must owe largely to environmental influences.
- Several studies have reported markers for genes that may influence IQ performance. But each of these genes, if confirmed, is likely to contribute just a tiny piece to the puzzle of genetic variation in intelligence.
- It is a mistake to draw conclusions about *group* differences from heritability estimates based on differences *within* a group. The available evidence fails to support genetic explanations of black–white differences in performance on IQ tests.
- Environmental factors such as poor prenatal care, malnutrition, exposure to toxins, and stressful family circumstances are associated with lower performance on intelligence tests. Conversely, a healthy and stimulating environment, and certain kinds of enrichment activities, can improve performance. IQ scores have been rising in many countries for several generations, most likely because of improved diet and education and the increase in jobs requiring abstract thought.

Beyond Nature versus Nurture

- Neither nature nor nurture can entirely explain people's similarities or differences. New discoveries about the role of noncoding DNA, and findings in the field of epigenetics, show that the interaction between genes and environment is far more complex than anyone once imagined. Genetic and environmental influences blend and become indistinguishable in the development of any individual.

Taking Psychology with You

- When deciding whether to have genetic testing, critical thinkers will consider the personal and social consequences, such as whether test results can reveal a risk that has practical relevance, could be misused by their employer or insurance company, might stigmatize them if others knew about it, would help them accept and live with a problem, or could create a self-fulfilling prophecy.

Key Terms

evolutionary psychology **71**
behavioural genetics **71**
genes **72**
chromosomes **72**
DNA (deoxyribonucleic acid) **72**
genome **72**
genetic marker **73**
evolution **75**
mutation **75**
natural selection **75**
mental modules **77**
sociobiology **80**
social Darwinism **85**
heritability **86**
identical (monozygotic) twins **88**
fraternal (dizygotic) twins **88**
intelligence quotient (IQ) **90**
epigenetics **95**