Genetic Determinants of Personality

CHAPTER 1

Chapter Outline

All Humans Are Alike
All Humans Are Unique

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Charles Darwin introduced the idea that the human species is the product of a long period of evolution in *The Origin of Species* and *Descent of Man*. His arguments had an enormous influence on the field of personality. First, his theory of evolution assumed scientific determinism—that is, the theory assumed that the most complex aspects of behavior in all species are subject to scientific and rational analysis and are not due to accident or divine intervention. This principle was accepted by psychologists in their study of both nonhuman and human behavior. Second, Darwin focused attention on the function or adaptive value of biological structures and behavior. Psychologists have been guided by this viewpoint as they search for the usefulness of a particular pattern of action. Still another implication of Darwin's work for the study of human personality is the importance of species differences and of individual differences within species. These issues are addressed in this chapter.

Darwin proposed a simple yet powerful theory to explain the process of evolution that linked the development of species with the concept of inheritance—the transmission of characteristics from one generation to another. He stated: "Any variation, however slight and from whatever cause proceeding, if it be in any degree of profitability to an individual . . . will tend to the preservation of that individual, and will generally be inherited by its offspring. The offspring, also, will thus have a better chance of surviving" (1869, p. 61).

Nearly every theory of personality tries to describe why people are the way they are. Personality theories are going to make the claim that all humans are alike and the propositions apply to everyone. Simultaneously, personality theories are going to try to explain why each human is different. In our exploration of the influence of genetics on personality, we will see this fully on display. We will start with the ways in which we understand how people are alike, and then we will explore the ways in which people are unique.

In this chapter we examine some of the genetic determinants of personality structure and behavior. Although neurotransmitters and hormones, brain mechanisms, and other biological factors influence personality, we focus here on the topic of genetics because of the vast research in this area and because it well illustrates the role of biological givens in behavior.

It is helpful to frame a genetic approach to personality within the context of evolutionary theory. Among the questions we discuss in this chapter are: What limitations do inherited characteristics place on learning? Do humans have instincts, or innate urges and unlearned patterns of behavior? Are there universal facial expressions or behaviors that are exhibited across cultures? And can it be demonstrated scientifically that personality characteristics and behavioral problems are in part genetically influenced? We will present evidence that the answers are yes and that a complete theory of personality must consider innate factors.

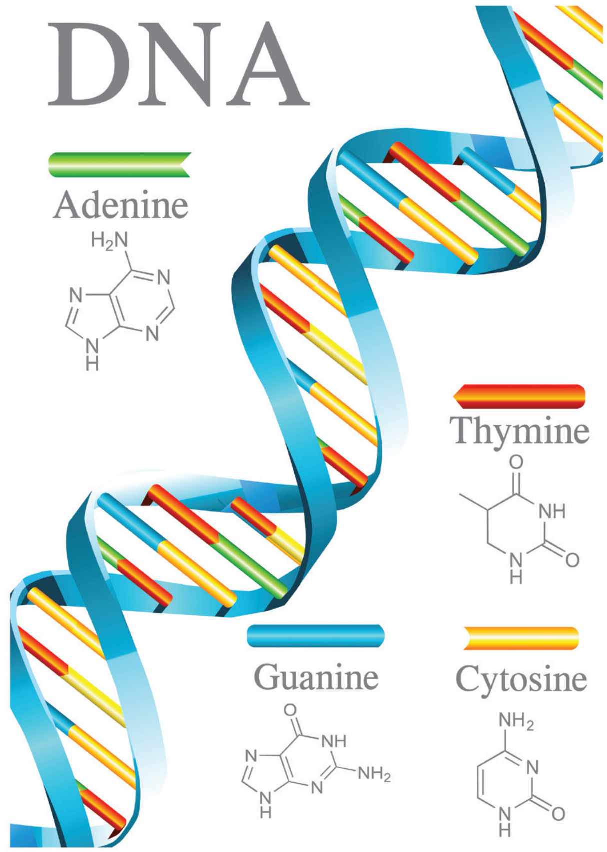
genome The organized set of DNA that every living thing has.

All Humans Are Alike

The human genome is made up of 23 chromosomes, which are then made up of a molecule called deoxyribonucleic acid (DNA). DNA has four bases: adenine, thymine, guanine, and cytosine. These are often denoted just by their first letter: A, T, G, and C. These four letters provide the instructions for making amino acids that then make up the various proteins and enzymes that make up living organisms. The process by which this happens is beyond the scope of this book, but it is important to understand some of the basics.

DNA is copied via another molecule called ribonucleic acid (RNA). In the process of copying, mistakes can be made. Furthermore, mutations can also occur due to exposure to radiation and other things in the environment. Most of the time, the mutations are harmless; some of the time, the mutations are harmful. Importantly, sometimes the mutation leads to positive outcomes and increases the chances of the organism or its offspring surviving.

Through the instructions on how to build the amino acids and how to arrange the amino acids into proteins and enzymes, the DNA provides the information needed to create brain structures, neurotransmitters, and hormones. These then become the building blocks of behavior. All humans have a **genome** that codes for these things, but there will be subtle differences among each person, as everyone (except monozygotic twins) has a slightly different genome. However, unrelated humans still share somewhere between 99% to 99.5% of their DNA. The general pattern is what makes us human and will therefore make us similar in many ways.



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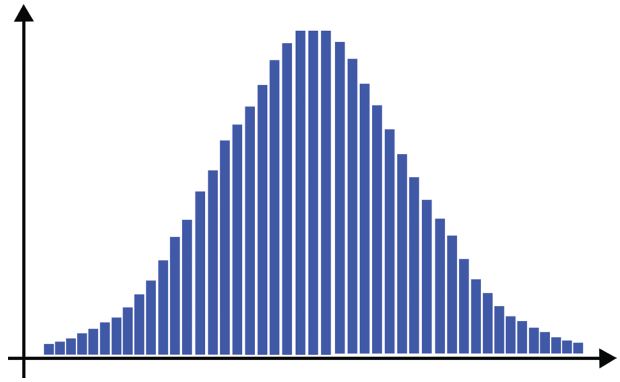
Our DNA is made up of four molecules: adenine, thymine, guanine, and cytosine.

It is important to recognize that most of what we will be examining will not be the result of a single gene, but rather the result of several genes acting together. The genes may be all pointing in a particular direction, or a few genes may point in one direction while the others point in the opposite direction. Consider the genes that are involved in height. Some genes may promote being tall, whereas other genes may promote being short. Some people will get many genes that point toward being tall; some people will get many genes that point toward being short. Most people will get a combination and end up somewhere in the middle. Traits that are made up of several genes are likely to be revealed as something that is normally distributed.



Traits that are due to multiple genes are likely to be distributed in a bell-shaped curve. People who get all the genes pointing toward being tall are likely to be tall; however, most people have a combination and are toward the middle of the distribution. Could we expect that people who have all their genes pointing toward shyness to be at one tail of the distribution of extraversion?
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The Question of Instincts

Instincts are regarded as genetic givens. An **instinct** or, more appropriately, instinctive behavior can refer to either (1) an unlearned, fixed pattern of activity found in all members of a species, such as nest building in birds and web spinning by spiders; or (2) a specific motivational tendency that is inferred from overt behavior. An instinct in this second sense is a potential toward action and is considered an unlearned "want" or "urge" built into the structure of the organism. Although the ends, or goals, of instincts (urges) are presumed to be fixed, the means of expression can be quite diverse.

instinct An innate, biologically based mode of response to certain stimuli.

Instinctive Patterns of Behavior

Recall that instinct, in addition to meaning a genotypic urge, also refers to an unlearned pattern of behavior that is characteristic of all members of a species of the same sex at the same level of development. Birds' responses to mating calls and squirrels' hoarding of food are examples of such unlearned patterns of responses. These behaviors are caused primarily by genetically transmitted physiological states and function they are akin to the built-in behaviors exhibited by plants, such as movement toward light. These instinctive behaviors frequently are not single responses, but are action sequences that follow a predetermined, predictable course. Furthermore, the observed behaviors often are crucial for survival and therefore are interpreted in an evolutionary sense. For example, it is known that the stickleback fish will attack any other fish of its color or even any object of this particular color. This behavior results in **species-spacing**, or spreading species members apart so that there is sufficient food available for survival. Distinctive birdsong often also has a species-spacing function.

species-spacing Spreading members of the same species across environment to enhance survival.

An interesting set of studies that combines instinct and learning was conducted with Rhesus monkeys (Cook and Mineka, 1989; 1990). One group of monkeys was trained to fear either snakes or flowers. A different group of monkeys watched film of the first group while the first group was trained to fear that stimuli. The monkeys that observed the other monkeys learning to fear snakes acquired a fear of snakes, whereas those that watched the flower condition did not learn to fear flowers. This would seem to indicate that they have an instinctual predisposition to learn to fear things that may threaten survival.

It often is difficult to prove with certainty that a response is innate or unlearned rather than learned and experience-based. In addition, the higher the organism is in the nonhuman-human scale the more likely that the behavior is influenced by learning. Among human beings one might expect to find few unlearned patterns of behavior, other

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Childlike faces elicit positive responses. This is true in humans as well as pets, like puppies and kittens.

than reflexive responses such as the eye blink or knee jerk. However, it is quite possible that there are innate reactions—fears, aversions, preferences for particular stimulus situations—that have significance for human personality. Fear of the grotesque or a child's responsiveness to the mother's breast and the warmth of her body are possible examples of such reaction tendencies.

Infant Features and Maternal Care

Whether behaviors such as maternal care among humans have genetic determinants cannot be demonstrated with certainty, although it is reasonable to suppose that they do. Such an inborn tendency would have great survival value for the species, in that the young would be protected from danger and starvation. It has been speculated that certain features of the young, particularly facial characteristics, operate as social signals and innately elicit complex emotions and behaviors (Berry and McArthur, 1986). A variety of facial features distinguish infants from adults. Infants have large heads in relation to their bodies, their faces are hairless and smooth—skinned, and they have a relatively large forehead and small chin so that the vertical placement of features is low in the infant's face. In addition, infants' eyes are large, their nose is small.

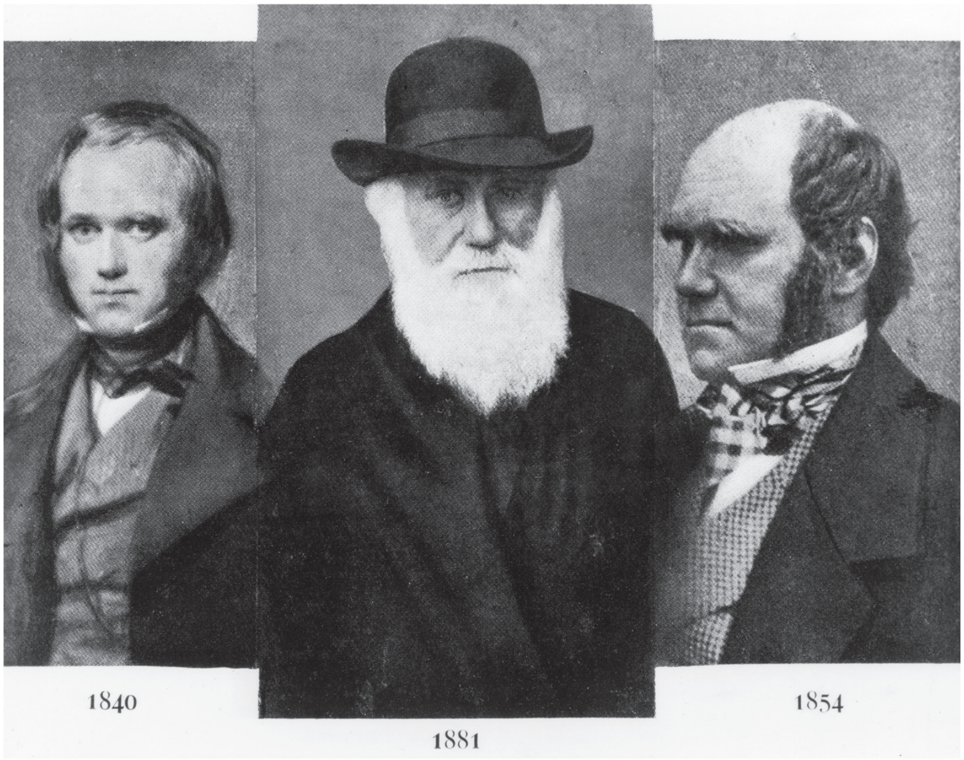
Berry and McArthur (1986) have shown that these infant facial features may elicit helping responses and positive emotions that, in turn, promote survival. Consider, for example, your reactions to the faces of infants, as opposed to their adult counterparts. It is evident that infant features call forth approach reactions and warmth. It has been contended that these features also influence responses toward adults. In one startling finding, it was reported that baby-faced criminal defendants were judged less harshly than mature-faced defendants, even when they had committed the same criminal offense (Berry and McArthur, 1986).

Evolutionary Psychology

Evolutionary psychology has sought to establish that even such social behaviors as conformity, altruism, and cheating have a biological or genetic basis using principles laid out by E. O. Wilson (1975, 1977). Wilson called his model Sociobiology, which helped lead to a field in psychology called Evolutionary Psychology. Evolutionary psychologists have noted that Darwinian principles account well for aggressive behavior. Aggressive individuals are likely to receive food and also may engage in more mating behavior. Hence, it is argued, those most aggressive will survive and pass on this trait to their offspring. However, it is difficult for Darwinian principles to account for altruism. Those with altruistic tendencies decrease their own "fitness" relative to others, and thus altruism would tend to extinguish over time.

Like Darwin, evolutionary psychologists also accept the view that survival-promoting behavior is passed on from one generation to another. But they contend that survival of the genes, rather than the individual organism, is the prime evolutionary tendency. This belief enables them to account for apparently altruistic actions. For example, a bird may risk its own life to warn the rest of the flock of impending danger. In so doing, the individual bird might not survive, but the survival of others with like genes is aided. Why do human beings help others who apparently are not related to them? Evolutionary psychologists argue that an agreement of "reciprocal altruism" has evolved because mutual help-giving augments the genetic pools of all participating parties.

These ideas have been invoked to explain a vast array of puzzling facts. For example, why should female ants devote their lives to helping the queen to breed, instead of breeding themselves? Wilson (2000) has pointed out that female ants actually share more genes in common with their sisters than they would with their own offspring. Thus, in order to perpetuate genes identical to their own, it is in their self-interest to assist the queen in producing more daughters.



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Charles Darwin.

Evolutionary psychology concepts have also led to reinterpretation of various facets of human sexual behavior. The male, evolutionary psychologists may argue, has one prime goal: to transmit as many of his own genes as possible to the next generation. On the other hand, the female must invest a great deal of time in each birth and can have only a very limited number of offspring. Thus, males are in general more promiscuous than females because their promiscuity has a genetic payoff. Furthermore, because females must invest more of themselves in each pregnancy, they are important resources that males must "purchase." As a result, in many cultures older males (who have more resources) marry younger women (who have many years of childbearing and child caring left), and women prefer men who are "good providers" (Buss, 2003, 2005; Fales et al., 2016). However, we should also examine this phenomena from a cultural vantage point. Historically, it has been difficult for women to accumulate wealth on their own, so the only way for them to get it was through a husband. Thus, a behavior of looking for a husband with access to wealth and resources can be explained through an evolutionary approach or a cultural approach.

It has been suggested that men might use two different reproductive strategies, sometimes referred to as "dads" and "cads" (Draper and Harpending, 1982). The first strategy involves finding a reproductive partner and investing time and resources in helping to raise their children. The second strategy is the promiscuous strategy mentioned in the previous paragraph: find as many reproductive partners as possible and not invest strongly in raising the children.

Likewise, women likely use two strategies. In one strategy, a woman looks for a reproductive partner who will invest in the offspring; thus, she is looking for a man who is using the dad strategy. In the other strategy, the woman is looking for a reproductive partner who will provide high-quality genes and will lead to "sexy sons" (Gangstead and Simpson, 1990; Weatherhead and Robertson, 1979). Those sexy sons could then conceivably use the cads reproductive strategy. Interestingly, women who are ovulating are more likely to misperceive a cad as a dad (Durante, Griskevicius, Simpson, Cantú, and Li, 2012). There is evidence that there are consistent changes in reproductive partner choices during the ovulatory cycle such that women prefer the sexier cads during fertile parts of their ovulatory cycle (Gildersleeve, Hasselton, and Fales, 2014). This pattern has been named **ovulatory shift** (Gangestead, Thornhill, and Garver-Apgar, 2005).

ovulatory shift A woman's preference for attractive healthy partners who may not invest in offspring during ovulation.

Evolutionary psychologists are not reluctant to extend their ideas to explain seemingly unrelated phenomena. For example, they anticipate that child abuse will be most prevalent toward stepchildren because not only do these offspring not carry the genes of the abuser (most typically the stepfather), but they even decrease the "survival fitness" of the stepfather (Daly and Wilson, 1996). Interestingly, data from Sweden (Temrin, Buchmayer, and Enquist, 2000) does not support this hypothesis.

Evolutionary psychologists point out that males have only one great disadvantage in breeding: they cannot be certain that the offspring are their own. Thus, sexual jealousy is aroused and courtship rituals have emerged to monopolize the female's time. During this extended courtship the male also can determine if the female is already pregnant. Evolutionary psychologists suggest that the maternal grandparents (the parents of the mother) will be more attached to the offspring than the paternal grandparents (the parents of the father) because of uncertainty regarding the "true" father. It is generally accepted that the mother's mother has prerogatives, such as the first visit to the baby!

Needless to say, these ideas have been controversial (Archer, 1988). The controversy involves primarily the extension of evolutionary psychology principles to complex human social behaviors. It is obvious that cultural factors greatly influence human actions. For example, how can evolutionary psychology account for the fact that today many men undergo voluntary sterilization and the birthrate in many countries is falling so rapidly that there is zero population growth? In spite of difficulties in explaining such facts, advocating this extreme biological view has proved exceedingly provocative and has spurred the interpretation and reinterpretation of a variety of phenomena.

Facial Expressions and Emotions

Darwin argued that human facial expressions are inherited and are modified very little by cultural experience. For example, he pointed out that the baring of teeth by humans in situations of anger and contempt is similar to the display of teeth among carnivores prior to a hostile attack or during an aggressive defense.

A number of studies have attempted to verify Darwin's insight. These studies bear on the biological basis of emotional experience as well as on the universality of emotional displays. Two basic paradigms have been followed in this research area: (1) examining the facial expressions of children born deaf and blind; and (2) analyzing the agreement concerning identification of emotions in different cultures.

Investigations reveal that blind and deaf children do display quite normal facial expressions (Eibl-Eibesfeldt, 1970, Freedman, 1964). Hence, these observations tend to support the universalistic, Darwinian explanation of facial expression. Of course, culture plays some role in the control of facial expression and in determining which situations are appropriate for eliciting and displaying particular emotions and facial expressions.

The cross-cultural research has been guided by identification of the so-called basic human emotions. Ekman and Friesen (1975) isolated six primary emotions—happiness, sadness, fear, anger, disgust, and surprise—and also identified the facial muscles associated with these emotional states. Photographs showing the facial expressions associated with these emotions were then shown to people in five different countries—the United States, Brazil, Chile, Argentina, and Japan—and the subjects were asked to identify the emotion portrayed. The percentage of agreement with the labels supplied by Ekman and Friesen was quite high across all countries used.

A baboon in full threat gesture, with teeth bared. Darwin pointed out that a human snarl has a similar facial pattern and suggested that emotional displays are genetically programmed.

In addition, natives of New Guinea, who had very little exposure to Western culture and were not subject to the possible confounding of media exposure, responded similarly to people in the other five countries. (However, it must be noted that individuals are more adept at this labeling task when selecting the appropriate emotion from a given list, rather than supplying their own interpretation without the aid of a preselected list.) In sum, it appears that facial expressions of some emotions are to a large extent a genetically based characteristic of the species (Ekman, 1993, 2016). Although these appear to be the six facially displayed emotions across cultures, it does not mean they are the only emotions. There are likely to be emotions that are unique to different cultures (Niiya, Ellsworth, and Yamaguchi, 2006) and other emotions that are more effective if not facially displayed.

The Need to Belong and Survival

Humans are a social species and survive and reproduce most successfully when they are part of a group. In the past, exclusion was likely to lead to death. Exclusion from a group is usually described using words associated with pain (MacDonald and Leary, 2005). Functional magnetic resonance imaging (fMRI) research has found that the same part of the brain is active when a person is in physical pain or experiences social exclusion (Eisenberger, Lieberman, and Williams, 2003).

Fear of exclusion also helps to explain one of the major fears that many people experience: public speaking. If a person speaks in such a way that he or she loses status or belonging, there will be negative survival or reproductive consequences. Because of these perceived high stakes, people who believe that public speaking could have this consequence are likely to experience anxiety (Baumeister and Tice, 1990).

sociometer A theory that suggests the function of self-esteem is to measure the extent to which people fit in their social environment.

Leary and his colleagues (Leary and Baumeister, 2000; Leary, Tambor, Terdal, and Downs, 1995) have suggested that self-esteem acts as a way to monitor the extent to which a person belongs and is important to social groups. In this model, self-esteem measures social belonging in the same way that a thermometer measures temperature; thus, they term this the **sociometer** theory of self-esteem. People who have a strong sense of

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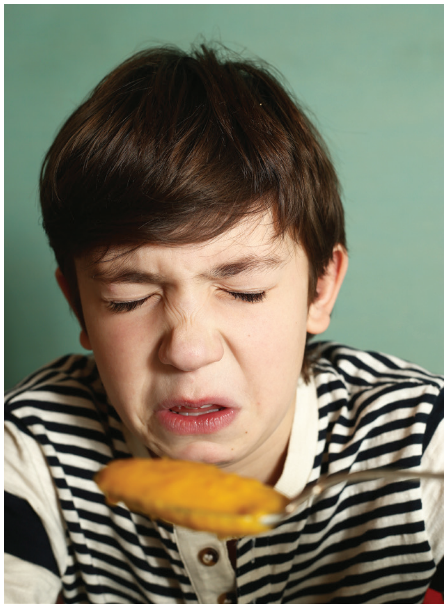

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The facial expressions of emotion that were identified across cultures are happiness, sadness, anger, fear, disgust, and surprise.

belonging will have high self-esteem, whereas people who do not feel as if they belong will have low self-esteem. Self-esteem is, therefore, an evolved mechanism by which humans are consistently checking belongingness.

Interestingly, there appear to be genetic differences in the ways in which people respond to social exclusion (Gallardo-Pujol, Andrés-Pueyo, and Maydeu-Olivares, 2013). They found that people with one gene respond strongly to being excluded, whereas those with the other version of the gene do not.

All Humans Are Unique

Despite cross-cultural similarities and the universality of some behaviors, it can equally be said that each human is genetically unique. Given the billions of possible inherited gene patterns, each individual is provided with an idiosyncratic genetic configuration. The resulting variability in genetic structure is manifested in individual differences in characteristics and behavior. Two basic procedures have been followed in studying the genetic determinants of individual differences. One method is experimental, involving the selective breeding of nonhumans. The other is nonexperimental in the sense that there is no intervention in the lives of its human subjects. The nonexperimental procedures include both twin and adoption designs. Finally, there are new approaches looking at loci on the genome that are associated with behavior.

The Experimental Study of Heritability

selective breeding Choosing organisms with positive characteristics to reproduce.

directional selection An extreme version of a trait or behavior may be preferred in some instances of natural selection.

balancing selection An intermediate version of a trait of behavior may be preferred in some instances of natural selection.

heritability The degree to which genetics plays a role in the development of a particular aspect of a trait or behavior.

For many years **selective breeding** has been unsystematically performed on domestic animals to enhance certain temperamental or behavioral characteristics, such as ferocity, docility, hunting ability, and so on. In more systematic laboratory settings, animals exhibiting a high or low degree of a certain behavior, such as emotionality, are selectively bred for generations and the emotionality of subsequent generations is then compared. The experimenter thus performs on a compressed time scale what natural selection is presumed to do during the course of evolution. In natural selection, high or low extremes of a characteristic or **directional selection**, may be favored. For example, natural selection in opossums evidently favored inertness in the face of danger; visual aggressive displays or strength and speed are favored in other species. In nature, as in the laboratory, there may also be **balancing selection**, which favors intermediate values of the characteristic in question.

The logic of breeding experiments is straightforward and nicely illustrates what is meant by the concept of **heritability**—the degree to which genetics plays a role in the development of a particular aspect of behavior in a particular population. Assume, for example, that we observe a group of animals learning a maze and that they attain scores of 1–10, based on the number of trials before success. That is, one animal learns the maze in a single trial, another takes two trials, a third requires three trials, and so on. Now, for example, we take the "brightest" animals, which require only one trial to learn, and we inbreed them. Of their offspring, we again inbreed the fastest learners. Assume that this procedure is continued for thirty generations. Now, if the thirtieth generation of animals still gives us scores of 1–10 in maze learning, we know that the ability to learn this maze has no heritability. Rather, the differences among the animals are due entirely to environmental factors. Conversely, assume that for this thirtieth generation, all the animals learn the maze in one trial. In that case, we would assume that maze learning was due entirely to genetic factors; heritability is the determining factor. In actuality in this situation, the variability among the animals, i.e., their differences in how many trials it took them to learn, will most likely decrease over generations, but will not disappear entirely. Thus, there will be both genetic and environmental determinants of learning, with the decrease in variability indicating the degree to which this behavior is influenced by genetic factors.

A representative study of selective breeding for a particular ability is illustrated in an investigation by Thompson (1954). Thompson measured the speed with which rats learned a maze for a food reward. Then he bred the low-error (maze-bright) rats with other maze-bright rats, and the high-error (maze-dull) rats with other maze-dull rats. The offspring of these matings were then tested on the maze. This procedure continued for six generations; by the sixth generation, the error scores of the two breeding populations were dramatically different. It is interesting to note that rats superior in maze learning do not necessarily master other problems as rapidly. Maze learning appears to be a specific ability.

Although the research by Thompson indicates that maze learning is influenced by heredity, this should not be taken to mean that environmental factors have no effect on such learning. Cooper and Zubek (1958) took the strains of rats bred by Thompson and reared them in either enriched or impoverished conditions. The enriched environment contained ramps, tunnels, and many movable objects, whereas the restricted environment included only a food box and a water tin. When the maze learning of the rats was assessed, the experimenters found that when the groups were reared in either extreme environment, their performance did not differ greatly. The enriched environment primarily raised the performance of the dull rats, while the restricted environment chiefly lowered the performance of the bright rats. Only in the normal environment were there differences due to an innate ability factor. Hence, *there is nothing absolute about heritability*; an organism's individual sensitivity to disparate environmental conditions may either mask or exacerbate inborn tendencies. What is inherited, then, is the way in which the organism responds to the environment, and heritability is in turn a function of the environment in which the behavior is studied.

Very similar conclusions regarding heritability have been reached in the study of emotionality. Broadhurst (1961) inbred high- and low-emotionality rats, selected on the basis of their defecation in an open field test. In this procedure, rats are placed in an unfamiliar environment, and emotional responses are inferred from the well-documented fact that fear causes defecation and urination. After six generations of inbreeding, there were dramatic differences between the populations, with the data resembling those reported by Thompson (1954) in terms of the magnitude of group differences and the increasing inequality in emotionality over the generations.

While it seems reasonable that learning ability and even emotionality may have a genetic basis, it is perhaps less sensible to believe that preferences or incentive values have a genetic component, as opposed to being entirely learned. However, breeding experiments have demonstrated that alcohol preference also may be inherited. It has been documented that particular strains of mice choose an alcohol solution over a water solution (Rodgers, 1966), while other strains avoid alcohol and prefer water. Furthermore, when strains with high and low alcohol preference are interbred, the offspring display an intermediate desire for alcohol as opposed to water (Rodgers and McClearn, 1962). Later in this chapter we will suggest that alcoholism among humans might also be determined in part by inborn tendencies.

The Study of Heritability Through Human Research

In contrast to studies of nonhumans, research using human populations is nonexperimental in the sense that there is no intervention or manipulation of variables because of obvious ethical constraints. Rather, individuals who vary in their degree of genetic relationship, such as foster parents and their children, natural parents and their children, siblings, dizygotic twins, and monozygotic twins, are compared and contrasted. Genetic similarity is a function of degree of kinship, so for genetically influenced characteristics, similarity in behavior and character should increase with biological relatedness.

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Many dog breeds were bred to be predisposed to particular skills. Border collies were bred for their herding instincts. Golden retrievers were bred to retrieve birds from the water; they even have webbed feet, which make it easier for them to swim.

HIGHLIGHT 1.1

Correlations

One of the most important statistics that is used in personality psychology is the correlation coefficient. The correlation coefficient allows the similarity between two variables to be quantified. The correlation coefficient has two components: sign and magnitude. The sign, positive or negative, tells us the direction of the relationship. If it is a positive correlation, as one variable goes up, the other variable also tends to go up; as one variable goes down, the other tends to go down. Height and weight are typically positively correlated: tall people typically weigh more than short people. For a negative correlation, as one variable goes up, the other variable tends to go down. We might expect classroom absences to be negatively correlated with grades; as absences increase, grades tend to go down. The magnitude can range from 0 to 1.0. When two variables are closely related, the magnitude will be near 1.0; when they are unrelated, they will be near 0. Considering both sign and magnitude, correlation coefficients can range from +1.0 to –1.0.

To create a simple example, let's imagine that researchers have people take each of the following measures: a measure of shyness, a measure of extraversion, and a measure of emotionality. They might want to know whether a relationship exists between the measure of shyness and the measure of extraversion. Using the correlation coefficient, they can answer that question. They might find that the correlation between the measure of shyness and extraversion is –0.78. This would indicate that there is a strong relationship between the two measures, and as shyness goes up, extraversion tends to goes down. They could then investigate whether extraversion and emotionality are related, and they might find the correlation to be +0.08. This would indicate that there is a very weak, or no, relationship between the two variables.

By squaring the correlation coefficient, we can quantify how much of the variability is predicted by one variable to the other. Remember, we are squaring decimals, .90 squared is .81, .50 is .25, and .30 is .09. If we find a correlation of .30, then .09 of the variance is predicted—less than 10%.

Chapters 7 and 8 discuss these ideas further, but it is necessary to understand the basics to understand the research on twins. Most of the time in personality research, the same person provides both variables. However, in investigating heritability of personality, different people would be measured on the same scale. So both twins might take an IQ test, or a parent and child might both take a measure of shyness, or siblings would be measured on extraversion.

The basic shortcoming of human genetic research is that the environments are not controlled. As a result, it is often impossible to infer with certainty that observed behavioral similarity is a function of biological relatedness and is due to inborn characteristics. In nonhuman research using inbreeding techniques, the environments are controlled and identical for each group.

Consider, for example, a hypothetical research study demonstrating that emotional mothers have highly emotional children, whereas non-emotional mothers have children with low emotionality. These data might be interpreted as demonstrating that emotionality is heritable. However, it is quite possible that these children had different home environments; perhaps highly emotional mothers create unstable environments which produce highly emotional children, whereas non-emotional mothers establish stable environments which give rise to children low in emotionality. In this investigation, the learning and the genetic contributions to emotionality cannot be separated. To help interpret the ambiguous results of such family studies, twin and adoption studies are often employed to disentangle genetic and environmental contributions.


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Identical (monozygotic, MZ) twins. Evidence indicates that many aspects of their temperament and behavior also will be similar.

The central research separating genetic from environmental contributions to human behavior involves a comparison between twins from different eggs (fraternal, or **dizygotic twins**) with those from the same egg (identical, or **monozygotic twins**). The latter type share completely identical gene pools; dizygotic twins, *on average*, share only about 50% of their genes. Hence, monozygotic (MZ) twins should be more alike in behavior than dizygotic (DZ) twins, if the behavior under study has a genetic component. This hypothesis assumes that the environments of DZ twins are as identical as the environments of MZ twins. However, such an assumption, although reasonable, is not always warranted. Identical twins may have more similar social learning histories; it has been found that they are more likely to dress alike, have common friends, and spend more time together than fraternal twins (Smith, 1965). However, this factor may be of limited importance, as parents of twins often incorrectly classify their children as MZ or DZ (Scan and Carter-Saltzman, 1979). See Table 1.1.

dizygotic twins Twins that develop from two fertilized eggs.

monozygotic twins Twins who develop from a single fertilized egg.

TABLE 1.1

Relationship	(A) Shared Genes	(C) Common Environment
MZ together	100%	100%
MZ apart	100%	0%
DZ together	50% on average	100%
DZ apart	50% on average	0%
Siblings together	50% on average	<100%
Siblings apart	50% on average	0%
Half-siblings together	25% on average	<100%
Half-siblings apart	25% on average	0%
Parent-child	50%	<100%
Grandparent-grandchild	25%	<100%
Adopted siblings	0%	<100%

By knowing the genetic relatedness, it is possible to begin making estimates about the contributions of the genotype to the phenotype. Different degrees of family relatedness lead to different amounts of shared genes. Again, remember we are examining only those genes that vary.

In principle, it is possible to study the effects of shared genes by comparing identical twins reared in similar versus different environments. Although such a sample is seldom available, some investigations have examined the similarities of siblings adopted in infancy and reared in foster homes, compared with unrelated individuals reared in these same homes. Any differences in the similarities within these two groups, given that all else is equal, are logically attributable to the genetic similarity of the sibs. Conversely, any differences in the behavior of the identical twins shows environmental and experiential influences on behavior.

phenotype The totality of observed characteristics or behaviors of an organism that result from the interaction between genotype and environmental influences.

The **phenotype** is going to be expressed as a function of the genotype and the environment. If we consider monozygotic twins raised together, the genotype is going to be the same, and the environment is going to be very similar, but there are likely to be differences in their experiences. One twin may have fallen and hit her head, another may have read more books, or one twin may have punched the other. These differences are known as nonshared environment.

Researchers often use the "ACE model" to describe the proportional influence on the phenotype (see Figure 1.1). The genetic contribution is labeled "A." The next component is the shared common environment, which is labeled "C." The shared environment includes things like experiencing the same parenting style, eating the same foods, being in a household with many or few books, attending the same school. As a simplifying assumption, it is assumed that people living together are going to share many of those things. The final component is the nonshared environment, which is labeled "E." The nonshared environment is the unique experiences that each person has. Even people living together are likely to have different experiences; in fact, some people have argued that all experiences are unique to one person.

Another way of estimating the heritability is to double the difference in the correlations of monozygotic twins raised together, to the correlations of dizygotic twins raised together (this method is usually represented as h^2). Remember the assumption is that the shared

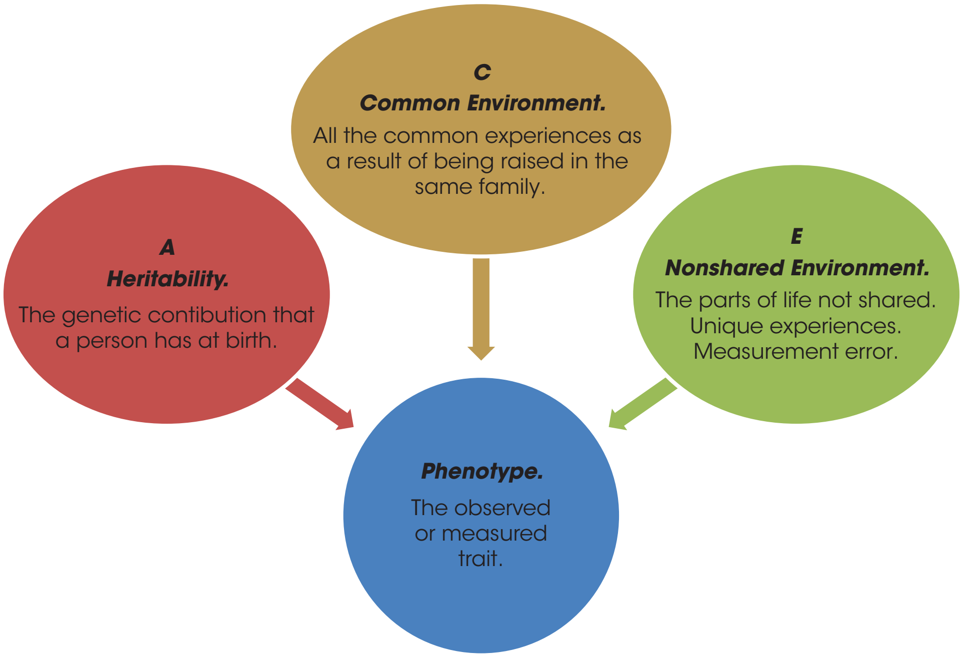

FIGURE 1.1 The ACE Model Specifies the Phenotype as Being a Function of A—Heritability, C—Common Environment, E—Nonshared Environment

environment is the same for monozygotic and dizygotic twins raised together, so the difference is due to genetic effects. A meta-analysis examined 50 years of twin studies that looked at a variety of human traits (Polderman et al., 2015). The studies examined physical traits, diseases, and psychological traits. The correlation for all the temperament and personality traits included in this analysis was .47 for MZ twins and .234 for DZ twins. For the computation of our heritability estimate, we would use $h^2 = 2(.470 - .234) = 2(.236) = .472$. This method is still used; however, many researchers in the field also use more sophisticated methods.

Temperament

> "... we now turn to the question of whether differences in human personality are heritable. We can be mercifully brief, yes." (Turkheimer, Pettersson, and Horn, 2014, p. 517.)

The role of genetics in the development of temperament has long been noted. In his studies of conditioning experiments, Pavlov examined individual dogs for long periods of time and observed striking differences in temperament that he attributed to inborn, neurological inequalities. **Temperament** may be defined as the "characteristic phenomena of an individual's nature, including his susceptibility to emotional stimulations, his customary strength and speed of response, and the quality of his prevailing mood, and all the peculiarities of fluctuation and intensity of mood" Allport, 1961, p. 34). Buss, Plomin, and Willerman (1973) selected four temperaments to study: emotionality, activity, sociability, and impulsivity. Twenty-item questionnaires were constructed, with five items for each temperament. These questionnaires were given to mothers of fraternal (DZ) or identical (MZ) twins. The mothers rated items such as "Child cries easily" on a scale of 1 (a little) to 5 (a lot). They found that on virtually all the items the correlations were higher for the MZ than for the DZ twins of both sexes. Toddlers and preschool children also show a genetic influence on temperament (Goldmith, Buss, and Lemery, 1997). In general, most dimensions of temperament tend to show heritability in the .20 to .60 range (Saudino, 2005).

temperament Behavioral characteristics that are present at an early age and that are believed to have some basis in biological processes partly determined by heredity.

Shyness

Kagan (Kagan, 1989; Kagan and Saudino, 2001; Kagan and Snidman, 1991) and his colleagues have argued for the heritability of a trait which leads to the behavior that we call shyness. They suggest that about 10% of healthy white children are born with a predisposition to act in an "inhibited" fashion in the presence of new stimuli such as strange individuals or strange situations. Another 10% are born to be more adventuresome and "disinhibited" in such situations.

Kagan and Snidman (1991) say that the antecedents of this cautiousness are present at around 4 months of age and can be seen in both high levels of motor activity and crying to stimuli. These predispositions have a tendency to persist into later life. While about 50% of the children studied at age 4 months no longer showed extreme fears at age 8 years, 80% were still not spontaneous. Additionally, about 75% of the shy children at age 8 had one or more unusual fears—such as fear of speaking in class or fear of attending summer camp—compared to 25% of those rated as disinhibited. Generally, shy children also exhibited a variety of physiological correlates such as more motor tension. Kagan (1989) suggests that these are based on brain activity that is easily aroused by unfamiliarity.

Finally, in line with our previous discussion on the difference between phenotype and genotype, Kagan, Arcus, and Snidman (1993) review data indicating that about 35% of the variability in the fear score of children at age 14 months is due to parenting behaviors. Parents who do not comfort their shy and fearful infants too much when they are upset (but who are not harsh) and who set limits have infants who show significantly lower fear scores. Thus both nature and nurture play a role in how fearful an older child is. Many children with an inhibited disposition can learn, for the most part, not to act shyly, although subtle signs of their tendency to act inhibited in strange situations may still be observed.

polymorphism Different versions of a gene.

At the molecular genetic level, a **polymorphism** (the technical way of referring to different versions of the gene) of the 5-HTTLPR has been identified in multiple studies as being associated with anxiety (Lesch et al., 1996; Miu et al., 2013; Schinka, Busch, and Robichaux-Keene, 2004). Arbelle and colleagues (2003) found that this polymorphism contributed about 7% of the variability in shyness among grade school children in their sample.

Introversion-Extraversion and Other Personality Traits

It has been suggested that introversion-extraversion may be the most genetically influenced of the personality traits. Introverts are defined as quiet, retiring, introspective, and not very socially active. Extraverts, on the other hand, are characterized as being outgoing, impulsive, and uninhibited, having many social contacts, and frequently taking part in group activities (Eysenck and Eysenck, 1964).

The best-known theory of introversion-extraversion relates this personality dimension to inherited differences in the functioning of the reticular activating system (RAS). This neurological activating system is located in various areas of the cortex and is responsible for an organism's level of arousal or degree of internal stimulation. Eysenck (1967) has suggested that under normal conditions introverts are more highly aroused than extraverts. Somewhat paradoxically, high arousal results in restraints or inhibited behavior because the cortex is exercising control over the more primitive brain centers (see Wilson, 1978). Extraverts on the other hand, being less normally aroused, are also subject to less cortical control.

Given this physiological conception, one might anticipate a high degree of heritability in this personality dimension; the twin studies support this belief. Several investigations have compared the similarity of MZ and DZ twins on self-report measures of extraversion (see Shields, 1976; Rose et al., 1988). These measures contain such items as:

- Do you often long for excitement?
- Are you mostly quiet when you are with people?
- Generally, do you prefer reading to meeting people?

Based on a review of over 25,000 pairs of twins, Henderson (1982) has concluded that the typical correlations between tests scores of MZ twins is about $r = .50$, while for DZ, the correlation is about $r = .20$. In one study, Shields (1976) found that identical twins separated from each other actually had slightly more similar scores on the extraversion scale than identical twins reared together, as if parents reacted to the twins or they reacted to each other in a manner that would enhance their differences.

Loehlin and Nichols (1976), making use of personality inventory responses, reported data that support the above conclusion. The subjects, twins who had taken the National Merit Scholarship Qualifying Test, were administered a variety of measures, including the California Psychological Inventory (CPI), which consists of eighteen different scales, some of which relate to the introversion-extraversion dimension. On virtually all of these scales the correlations of the scores for the MZ twins approximated $r = .50$; those for the DZ pairs were $r = .20 – .30$.

The dominant model of traits (see Chapter 9) suggests that there are five major traits, of which the extraversion dimension is one. The other four are agreeableness, conscientiousness, neuroticism, and openness to experience. Because of the importance of these traits, there have been many studies examining their heritability. In general, the five trait dimensions appear to have a heritability estimate in the range of .40 to .60 (see Table 1.2).

Altruism and Aggression

It already has been suggested that aggression and altruism are products of long evolutionary histories. Rushton et al. (1986) examined the heritability of these behaviors in a large study of twins. They mailed questionnaires to adult twin pairs assessing altruism, empathy, nurturance, aggression, and assertiveness. The altruism scale, for example, included

TABLE 1.2 The Heritibility Estimates for Five Personality Traits

Source	E	A	C	N	O
Loehlin, McCrae, and Costa (1998)	.57	.51	.52	.58	.56
Jang, McCrae, Angleitner, Riemann, and Livesley (1998)	.50	.48	49	.49	.48
Riemann, Angleitner, and Strelau (1997)	.60	.57	.71	.61	.81
Waller (1999)	.49	.33	.46	.42	.58
Johnson and Krueger (2004)	.49			.56	
Floderus-Myrhed, Pedersen, and Rasmuson (1979)	.60			.54	

items such as: "I have given directions to a stranger" and "I have donated blood." The findings are similar to those already presented in that the correlations for the MZ pairs were near $r = .50$, while for the DZ pairs the correlations approximate $r = .15$.

It appears from the research that many personality traits may have a genetic component. This same research, however, clearly shows that genes do not account for all variations in behavior and that environments also determine personality.

Heritability Estimates Depend on the Sample

One of the most important caveats when considering the genetic contribution to heritability of behavior is that the heritability estimate is based on the population from which the sample is drawn. Variability in the experiences of the population will lead to lower heritability estimates than populations that experience a more similar environment during development.

Let's use an example that may be familiar from grade school. If we take a bunch of different seeds for different types of corn and plant them, we are likely to get corn stalks of different height. If we take a single strain of seed corn that is nearly identical and plant those seeds, we would see less variability in the height of the corn stalks. Now, let's create a few different conditions for our thought experiment. In one condition, we mix up all the seeds, and then we plant them in a mix of good and bad soils, with variable exposure to light and rain, and some we give fertilizer, and some we do not. If we find variability in the height of the corn stalks, is it due to the seed (the genes)? Or is it due to the soil, water, and fertilizer (the environment)? We really do not know. In a different condition, we use our mixed-up seeds in the same soil, receiving the same water and fertilizer. Now, if we see a difference in the height, it is likely to be due to the difference in the seeds (the genes). We would see the greatest heritability estimate in the last case. One of the ironies of heritability estimates is that the environment changes the heritability estimate, with more uniform environments producing higher heritability estimates. After all, if the environment is the same, the only thing that will vary is the genes.

Interesting research revealing this point is work by Turkheimer and his colleagues (2003). From a large sample, they used MZ and DZ twins who had completed the Weschler Intelligence Scale for Children. The twins were also identified as coming from either low or high socioeconomic status (SES) backgrounds. Socioeconomic status reflects the wealth and prestige of one's family. In this research, for the low SES group the correlation for MZ twins was .68, and for DZ twins it was .63. The heritability estimate was .1, while the estimate for common environment was .58. For the high SES group, the correlation on intelligence for MZ twins was .87, and for DZ twins it was .51, giving a heritability estimate of .72 and a common environment estimate of .15. To use the metaphor from the beginning of the highlight, the wealthy children had good soil and fertilizer, so the genes determined the outcome. For the poorer children, the things that happened in their environment such as parental attention, good or bad nutrition, school quality, and so on, had a great impact on the observed intelligence scores. Thus, SES interacts with the gene. To add to the complexity, in countries in which access to health care and education is more uniform, the interaction goes away (Trucker-Dobbs and Bates, 2016). So, it appears that this interaction interacts with the nation in which the data were collected. If you remember nothing else, heritability estimates depend on the population from which they are drawn.

In addition to the heritability estimate depending on the sample, it is important to remember that the estimate is drawn from the full sample, and not from a single individual. It would be inappropriate to say that 72% of the intelligence for someone in the sample is due to genes. The heritability estimate does not apply to an individual.

Other Genetic Aspects of Personality and Behavior

Research on the genetics of behavior has become a vigorous and expanding area in recent years. There are now studies which have reported finding genetic aspects of how much television we watch (Plomin, Corley, De Fries, and Fulke, 1990), the likelihood of our getting divorced (McGue and Lykken, 1992), whether we believe in God or not (Tesser, 1993). There has even been a study that used twins and siblings, and found that a person's attitudes about exercise appear to have a genetic contribution in the .4 to .5 range (Huppertz et al., 2013).

Mental Illness and Social Problems

concordance The rate at which pairs of individuals share a trait, status, or diagnosis.

discordance The rate at which pairs of individuals do not share a trait, status, or diagnosis

The twin studies of heritability of personality required the assignment of quantitative degrees of the trait under investigation to the individuals being compared. This quantitative trait score was derived from reports of others, self-reports, or actual observations of behavior. Examination of the genetic determination of mental illness and social problems, on the other hand, involves the assignment of individuals to a category, such as schizophrenic, alcoholic, criminal, and so on. Then the rates of **concordance** (both twins classified in the same category) and **discordance** (twins in different categories) are examined. The genetic hypothesis concerning social problems is corroborated when higher concordance rates are displayed as a function of biological relatedness.

The mental illness that has been most extensively investigated from a genetic perspective is schizophrenia. Gottesman (1993) has provided a summary of the nine studies comparing monozygotic and dizygotic twins. The mean concordance rate for monozygotic twins was 39%, while for dizygotic twins it was 10%. Gottesman suggests that estimates of the heritability of schizophrenia range from .42 to .63, with estimates for the effects of the environment ranging from .29 to .53.

In addition to twin studies, investigations utilizing entire families and adoption studies also support the genetic hypothesis. The logic of the family study approach is straightforward—if schizophrenia is an inherited disorder, relatives of schizophrenics should also exhibit a higher incidence of schizophrenia. Further, the closer the relative in terms of genetic relatedness, the higher should be the concordance rate. It has been estimated that the risk of schizophrenia for first-degree relatives (e.g., parents of a schizophrenic) is about 8% and about 2.5% for second-degree relatives (e.g., uncles and aunts), as compared to the general population base rate of 1%.

In addition, adoption studies reach the same conclusion. The adoption study design removes the possibility of post-natal environmental interaction between the adopted child and biological relatives. One study has shown that when children of a schizophrenic mother are raised by normal mothers, over 10% of the adoptees become schizophrenic (see Faraone and Tsuang, 1985; Plomin, 1989).

The data from another study (Cardno et al., 1999) indicates that of 49 MZ twin pairs in which one twin was diagnosed with schizophrenia, 20 of the co-twins were also diagnosed with schizophrenia, a concordance rate of 40.8%. For the DZ twins, the concordance rate was only 5.3%. Schizoaffective disorder showed an MZ concordance rate of 39.1%, while the concordance rate for DZ twins was 4.5%.

These findings have resulted in a search for the specific chromosome that may be carrying the schizophrenic gene. However, given that different types of schizophrenia have different concordance rates, the search for a single gene seems unlikely to be successful. In fact, it is generally believed (Gottesman, 1993) that schizophrenia involves more than one gene.

In a similar manner, manic-depressive psychoses and affective disorders appear to have a genetic component. Recent research has shown the same pattern of data as discussed for schizophrenia, although the strength of the genetic contribution is controversial (see Plomin, 1989).

In addition to mental illness, a variety of social problems, including criminality and alcoholism, have some biological bases. Data are quite clear that crime virtually everywhere and throughout history is a young man's pursuit. That is, in greatly diverse cultures, age and sex influence crime rates. There also is evidence that there are general sex differences in aggression that appear to be at least in part traced to biological factors (male sex hormones). In support of the biological approach, twin studies have revealed that identical twins are more similar in delinquency than are fraternal twins, independent of amount of shared activities. In addition, adoption studies have shown that boys with criminal biological parents and noncriminal adopting parents were more likely to have criminal records than those with noncriminal biological parents and criminal adopting parents (Chapter 18)! These studies do not demonstrate that there is a "criminal gene." Rather, other inherited traits such as temperament and intelligence are likely contributors to the tendency to commit criminal acts (Mednick, Brennan, and Kandel, 1989; Mednick, Moffitt, and Stack, 1987; Wilson and Herrnstein, 1985).

Finally, recall that the preference for alcohol differed greatly among strains of mice. Humans also apparently have inborn preferences or susceptibility to alcoholism, for investigations reveal a marked heritability of this problem. (Of course, preference for alcohol among rats and alcoholism among humans should not be considered identical phenomena.) It has long been recognized that alcoholism is a familial disorder in that rates of alcoholism are far higher among relatives of alcoholics than among the general population. Goodwin et al. (1973) even found that where children have been separated from their biological parents at birth or shortly thereafter, the presence of alcoholism in the biological parents is of far greater predictive significance for the development of this disorder in the children than is the presence of alcoholism among the adoptive parents. An offspring of an alcoholic parent is more likely to become an alcoholic even when raised by nonalcoholic foster parents than is an offspring of nonalcoholic parents when raised by alcoholic foster parents. In general, the data have revealed a threefold to fourfold increased risk for this disorder in sons and daughters of alcoholics, even when raised by nonalcoholic adoptive parents (see Schuckit, 1987). McGue (1999) estimates that there is a 50% to 60% genetic contribution toward alcoholism. At the molecular level, two candidate genes appear to be associated with metabolism of alcohol, and three other genes may also play a role (Edenberg and Foroud, 2013).

It is likely that what is inherited is only a predisposition in which social-cultural factors play a role in the manifestation of alcoholism. The relative roles of genetics and culture are exceedingly complex. For example, it has been suggested that the Chinese drink little because of a genetic propensity to become ill with alcohol intake. Clearly, then, the disentanglement of genetic from cultural factors cannot be readily resolved, and simple instances of a genetic or a cultural influence, on closer inspection, reveal contributions from the other source.

The Nonshared Environment Effect

One of the most startling findings to come out of recent genetic research is the suggestion that the shared environments that siblings grow up in may have very little effect on their personalities (Rowe, 1994). That is, two genetically different siblings growing up in the same family will be no more alike in personality than if they had grown up in different families. This conclusion is based on a variety of researchers' finding of very low correlations between siblings on measures of various personality traits (Loehlin, 1989; Plomin, Chipuer, and Loehlin, 1990; Reiss, 1993).

Low correlations mean that although siblings may share the same family in a general, physical sense, their psychological environments may nonetheless be different. Interest is now shifting to an examination of the impact of nonshared environments on personality. Both Plomin et al. (1990) and Reiss (1993) have suggested that family dynamics play a role. One child is not treated the same as another child, and relationships among siblings vary. In addition, other aspects of the child's environment, such as relationships with peers outside the home or with teachers, probably differ among siblings brought up in the same home.

Molecular Genetics

One of the most exciting recent developments has been the ability to scan the entire genome to find polymorphisms that may be associated with characteristics and behavior. The success of this enterprise has been mixed, however. As researchers find correlations between genes and personality, there has often been a failure to replicate the finding. One researcher will find the effect, and then another, or even the same research group, will be unable to find the same effect. Another problem with this approach has been termed "the chopsticks gene" (Hamer and Sirota, 2000), where the cultural effect of eating with a particular utensil is correlated with a gene. With these caveats in mind, there is interesting research investigating polymorphisms and personality.

Genome Wide Association Studies (GWAS) scan the entire genome to identify candidate loci that are correlated with a measured aspect of personality. The researchers use one sample to scan for the association between genes and behavior and then use another sample to replicate the finding. Commercial sites like 23andMe.com and Ancestry.com allow people to investigate aspects of their own DNA. A person can send in DNA samples by swabbing the inside of his or her own cheek. Researchers have used some of these databases along with purely research-based databases to have access to really large samples of different people's DNA. Of course, they can only investigate the aspects of personality that happened to be reported at the same time that people submit their request for their analysis.

As indicated earlier in the chapter, most traits will be based on several polymorphisms (Chabris, Lee, Cesarini, Benjamin, and Laibson, 2015), not just a single one. Using GWAS, Reitveld and colleagues (2016) identified three candidate single nucleotide polymorphisms (SNP) that were associated with years of schooling. The discovery sample was based on over 95,000 people. They then used replication samples of over 23,000, 3,000, and 6,000 people. Importantly, the results replicated. These three SNPs together seem to account for 2% to 4% of the variance in years of education.

Criticisms of Genetic Views of Personality

Few would now debate that genetics play a role in personality development. What is debated, however, is the question of how much of a role and how that role is played. Findings that genetics contribute to divorce, belief in God, television watching, and the like would suggest that large proportions of our lives are genetically influenced.

However, this issue is more complex than it seems. First, there is no gene for television watching (how would it have manifested itself 100 years ago?). Further, two to three centuries ago in western Europe divorce was much more uncommon than it is today. It is likely that if genetic studies had been done on divorce at that time no effects would have been detected because divorce was such a rarity. While genetic causes for behaviors such as television watching and divorce can be found, it is likely that such behaviors are actually mediated by other genetic factors such as personality (McGue and Lykken, 1992). It is clear that there is a genetic influence, but what does "influence" even mean (Turkheimer, 2016)? The attempts at finding the exact genes leading to a particular trait have been met with failures to replicate or account for exceedingly low amounts of the variance.

A number of writers have criticized the concept of heritability, the idea that one can give a percent figure to the degree to which a trait is inherited. Bronfrenbenner and Ceci

(1993) have pointed out that the degree of heritability of a trait depends on the environment, and others have noted that an estimate of heritability from a given research study holds only for the sample of subjects studied in that investigation. One cannot generalize heritability estimates for the whole population. Others have pointed out that genetically oriented researchers do not adequately measure the environment in their studies and so are not really able to assess the impact of the environment. This has led to the possibility that heritability estimates of various traits are inflated. For instance, in adoption studies twins are separated at birth and adopted by different families. To estimate the heritability of a trait, such as television watching, one then correlates the degree of television watching in each adopted twin. However, twins are typically adopted into families of similar social class that are likely to provide similar environments. While this similarity might not affect the finding that television watching has a genetic component, it might inflate the magnitude of the heritability estimate.

Summary

1. A characteristic or a predisposition can be both inherited and modified by environmental factors and experience.
2. The genome is made of 23 chromosomes, and unrelated humans are 99.5% genetically similar to each other.
3. *Instinct* has two meanings: (a) an unlearned, fixed pattern of activity such as nest building in birds, and (b) an inner "want" or "urge."
4. *Evolutionary psychology* seeks to establish that complex social behavior has a biological or genetic basis.
5. Some facial expressions appear to be universal. This observation supports the Darwinian belief that expressions are inherited behaviors.
6. *Selective breeding* experiments have demonstrated that specific abilities such as maze learning and traits such as emotionality have genetic components. The offspring in such studies tend to behave similarly to their parents.
7. Twin and adoption research has demonstrated that temperament and personality traits have genetic components.
8. Studies have demonstrated a genetic basis for mental illnesses like schizophrenia and for social problems like criminality and alcoholism.
9. Molecular genetics has shown the relationship between gene loci and some aspects of personality. However, the variance has been rather small.
10. The nonshared environment effect, that siblings growing up in the same family environment appear to have little in common in terms of their personalities, suggests that siblings may actually experience different environments within the same family.

Key Terms

balancing selection (p. 12)
concordance (p. 20)
directional selection (p. 12)
discordance (p. 20)
dizygotic twins (p. 15)
genome (p. 4)
heritability (p. 12)
instinct (p. 5)
monozygotic twins (p. 15)
ovulatory shift (p. 9)
phenotype (p. 16)
polymorphism (p. 18)
selective breeding (p. 12)
sociometer (p. 10)
species-spacing (p. 5)
temperament (p. 17)

Thought Questions

1. Can you think of any apparently instinctive patterns of behavior in pets you have observed? Do you think you can read their emotions?
2. Why might women pursue different reproductive strategies at different points in their ovulatory cycle?
3. Why can't heritability estimates be applied to the individual?
4. If the genes are discovered for shyness, would parents consider genetic engineering to change those genes?