CHAPTER 4

Evolutionary and Genetic Explanations of Violent Crime

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Nothing in biology makes sense except in the light of evolution.

—Theodosius Dobzhansky (1997)

Most people can recall images of violence and aggression between wild animals. You may have seen nature programs on TV in which a leopard hunts an impala. Using stealth to get close to its prey, the leopard springs with deadly force and suffocates the impala with a sustained bite to the throat. Another form of violence you may have seen involves male bighorn sheep slamming their heads together in contests over potential mates, their massive curled horns absorbing several thousand pounds of force with each blow. Closer to home, you may have poked a stick in an anthill and watched as an army of ants attacked the invading object in defense of their home.

Aggression in the animal kingdom helps animals to obtain food, compete for access to a mate, and protect territory. These forms of aggressive behavior have been favored by a process called *natural selection* because they facilitate the reproduction of genes in the aggressive animals, either directly, as in the case of the bighorn sheep competing for a mate, or more indirectly, by aiding survival so that an animal or its close kin can reproduce later, as in the cases of the hunting leopard and the territory-defending ants.

Case Study: Murder Among Chimps

Since 1975, primatologist Frans de Waal has been studying the social organization of a colony of chimpanzees at the Arnhem Zoo in the Netherlands (de Waal, 1998). The shifting alliances and coalitions among the chimpanzees, and the complex behavioral mechanisms that regulated these relationships, were a revelation to de Waal. While physical conflicts, including slaps, thrown objects, and bites, did occur, the intricate and nuanced nature of the colony's social life is what really stands out when one reads *Chimpanzee Politics,* de Waal's account of his time at Arnhem. The Arnhem chimpanzees appeared to be much more sophisticated than the popular image of the playful and "silly" chimp. They also shattered their peaceful reputation because in 1980, "during the night of 12–13 September, the males' nightcages turned red with blood" (de Waal, 1986, p. 243). When attendants inspected, they found that the dominant male, Luit,

> showed numerous deep gashes on [his] head, flanks, back, around the anus, and in the scrotum. His feet, in particular, were badly injured (from one foot one toe was missing, from the other foot, several toes). He also had sustained bites in this hands (several nails were missing). The most gruesome discovery was that he had lost both testicles. All missing body parts were later found on the cage floor (de Waal, 1986, p. 243).

Luit died later that day.

Over the course of several years, the three most prominent males—Yoroen, Luit, and Nikkie—had been jockeying for the alpha, or most dominant, position within the Arnhem colony. With this position came not only a considerable degree of deferential behavior from the other chimpanzees in the group, but, most important, the largest number of matings. Yoroen, the oldest, had once been the alpha male in the group before he was unseated by Luit with the help of Nikkie. Yoroen subsequently began courting Nikkie, ultimately allowing Nikkie to ascend to the top spot in the colony. Ten weeks prior to the attack, however, Yoroen had withdrawn his support for Nikkie, allowing Luit to once again gain alpha status, until the fatal night described above. Since neither Nikkie nor Yoroen had any major injuries, it appears that Yoroen had once again switched sides and joined Nikkie in the lethal attack on Luit.

Yoroen had skillfully played Luit and Nikkie against each other. As the kingmaker and "favorite" to whichever alpha he was supporting at the time, Yoroen was able to acquire a large number of matings within the colony. However, while much attention has been paid to the males in the group, de Waal makes clear that the females also played an essential role in regulating the status hierarchy of the males. The males regularly courted the support of the females with embraces, grooming behavior, and kisses. Threatening gestures and physical conflicts for "betrayals" also regulated relationships within the colony. For example, Puist—a female who was particularly close to Luit—attacked Nikkie and chased him up a tree the day that Luit died and kept him there for 10 minutes with threatening, violent behavior.

Modern sexual selection theory suggests that in some social species, like chimpanzees and humans, because of differential parental investment (i.e., females invest more) as well as the great variability of fecundity among males (i.e., some males have lots of children and other males have none), competition for social status and, thus, mating opportunities might be quite intense, and consequently more violence might occur. This is why we observe much more violence among men in all human societies as well as among the chimpanzees in the Arnhem colony.

It is easy to see a parallel between the killing of Luit and the assassination of a Mafia boss or a gang leader by ambitious and ruthless underlings striving for power. However, status competition appears to play a large role in more commonplace acts of violence among men. As Daly and Wilson (1988) have argued, "a large proportion of the homicides in America . . . have to be understood as the rare, fatal consequences of a ubiquitous competitive struggle among men for status and respect" (p. 146). Moreover, the type of moralistic, retributive aggression that Puist demonstrated in her attack on Nikkie can sometimes be entangled in human status competitions. It is difficult to ignore the fact that the perpetrators of school shootings, such as those at Columbine and Virginia Tech, seem so often to be motivated by a desire for revenge or retaliation against those who they feel have "degraded" or diminished their status.

Of course, humans are different from chimpanzees. We gain some insight into the general patterns of human behavior by observing our closest cousins, the chimpanzees. However, humans also employ mechanisms other than those used by chimpanzees to regulate status and power competitions—the law, for example. Because we use the law to regulate our competitions, we see a greater use of violence in those areas of our society where the law does not reach, such as gangs and the Mafia.

Here are three more acts of aggression that will strike a familiar chord if you've watched the news. First, consider a young man attacking another young man on the street, beating him unconscious and then robbing him of his wallet. Second, imagine two men in a bar arguing over the affections of a women. This type of event is common enough that it should not be too hard to picture. During this dispute, one of the men pulls out a gun and shoots the other man dead. Third, members of a street gang notice that members of a rival gang are hanging out on a street corner in a neighborhood where they "don't belong." To make clear that these rivals are trespassing, the gang members open fire on them.

Like the first set of examples, these acts of human aggression also may exist because of the reproductive consequences that aggressive behavior had for our ancestors. In fact, it is conceivable that acts of human aggression have served reproductive functions that are not too dissimilar from those in the animal examples. For example, the mugging that was just described secured money that may be used to purchase, among other things, food, clothing, or housing. The barroom shooting occurred over the affections of a potential "mate." Finally, our hypothetical gang warfare involved, at least implicitly, the defense of territory.

These human acts of aggression are certainly more complicated than our animal examples, given the very subtle and sophisticated nature of human social life. Nonetheless, these human acts of aggression may have been naturally selected to a similar degree as aggression in animals. If so, many acts of human aggression and violence exist because of the role they have played in passing genes on to future generations. At least under some circumstances, aggressive individuals may have passed their genes on at higher rates than relatively passive individuals. These possibilities will be the focus of this chapter.

This chapter will acquaint you with an amazing possibility: The tendencies humans have toward violence, including that which is considered criminal, have evolutionary and genetic roots. In the first section, this chapter will describe the process of natural selection in order to show how this evolutionary force may have impinged upon tendencies toward aggression. Next, we will explain how a special type of natural selective model, known as sexual selection, may have also played a role in making males more violent than females, especially during their most active reproductive years. Following that, we will discuss efforts to isolate genetic influences on violent behavior and will briefly describe several genes that have been identified in relation to violence. Before we continue, however, a couple of introductory remarks are in order.

First, it is important to remember that simply because humans may have a naturally evolved capacity for violence and aggression does not mean that violence is a good thing, nor does it mean that society cannot and should not try to control such behavior. Humans also have a naturally evolved susceptibility to tooth decay and bacterial infections, but these conditions can and should be controlled for our well-being. Likewise, humans do not simply have violent tendencies; we can also cooperate, empathize, negotiate, and live in harmony. In fact, we have used our evolved intellect to construct a network of legal and administrative procedures—the criminal justice system—to reduce violence and maintain social order (Ellis, 1990).

It is the large number and sophistication of our evolved capacities—what evolutionists refer to as *adaptations*—that make human behavior, criminal or otherwise, so difficult to understand. As an example of the large number of evolved capacities that can be brought to bear in a criminal enterprise, consider the infamous serial killer Ted Bundy, who lured some of his female victims by faking an injury and then asking for their assistance in order to get them into a vulnerable position. His violent tendencies, combined with human capacities for language use, deception, and cunning, resulted in a horrific series of rapes and murders. To understand these capabilities, which exist in nearly all of us to some degree, a theoretical framework is needed. Increasingly, criminologists are turning to biology for guidance.

Darwin's theory of evolution is a valuable tool for understanding the physical appearance of animals as well as their behavior, including violent behavior. This is the point that the great geneticist Theodosius Dobzhansky makes in the epigraph at the beginning of this chapter. The theory of evolution by natural selection has become the central organizing principle for understanding why living things are the way they are and why they do what they do.

While the concept of natural selection is rather simple, it can be dauntingly subtle and far reaching in its applications. Let us briefly examine the concept and how it helps us to understand the evolution of life.

Evolution by Natural Selection

Biologically speaking, *evolution* just means change within lineages of organisms over the course of successive generations. The so-called "fossil record" provides irrefutable evidence that life forms have radically changed over the passage of eons.

While there has undoubtedly been evolutionary change in the forms of life over geologic time, the process that really does the "designing" was a major biological mystery. In the mid-19th century, Charles Darwin (1859) proposed a theory in which the driving force behind the evolution of species was identified as *natural selection.* It is a concept that can be explained in a variety of ways, but it basically means differential survival and reproduction of organisms depending upon the influence of their genes.

Natural selection can be thought of in terms of two interlocking steps. The first step is the production and existence of genetic variation in a population of organisms. The second step is the differential survival and reproduction of these genetically variable organisms. In order to more clearly understand this process, let us consider the hypothetical leopards discussed earlier.

A population of leopards, like all populations, will exhibit variation in traits and abilities, some of which is attributable to genetic factors. When we talk about genetics or genes, we are referring to organic molecules that are inherited by offspring from their parents and that constitute the recipe for constructing the proteins out of which living things are made—most of your dry weight is protein. All of the leopards will differ from each other in terms of things like lung capacity, muscle mass, volume and connectivity of nervous system fibers, and so on, all of which are influenced by the slightly different genes possessed by the leopards in this population. This is the first step from above—genetic variation in the population.

The genetic variation ultimately comes from *mutations,* which are simply slight errors that occur in the copying of the genetic material that is passed from parents to offspring. For example, you, like all humans, possess roughly 100 to 200 unique genetic mutations (Nachman, 2004); that is, there are roughly 100 to 200 points along the 23 chromosomes that you inherited from each of your parents at which you are uniquely different from either your mother or father. While 100 to 200 mutations might seem like a lot, it is useful to remember that you have approximately 3 billion nucleotide base pairs in the DNA you received from your parents (3 billion points at which your DNA can differ from either of your parents), so 100 to 200 mutations is a small fraction of your total DNA. The vast majority of these mutations have no effect whatsoever. In fact, much of your DNA does not seem to do much of anything, and many of these mutations occur in this noncoding DNA (it is sections of this noncoding DNA that are used for DNA fingerprinting). However, many genetic mutations might be harmful to the organisms possessing them, while other mutations may be beneficial to the organisms bearing them.

Genetic variation in a population is also created by sexual reproduction—or recombination—which ensures an almost limitless supply of genetic variation for natural selection to work upon. In fact, sexual reproduction itself may have been an adaptation to deal with the harmful accumulation of deleterious mutations in the genetic makeup of organisms (Kondrashov, 1982). At any rate, when it comes to genetic variation in a population, because of sexual recombination, an offspring will often mix the genetic mutations of its mother and father. So each member of our hypothetical population of leopards is slightly different from every other member genetically, and these genetic differences influence things like muscle mass, visual acuity, lung capacity, and so on. Now for the second step in the process: differential survival and reproduction.

This second step is natural selection itself. Because of the slight differences in our population of leopards in terms of things like muscle mass, lung capacity, and nervous system function, some leopards will be better than others at hunting and feeding, and some of these differences will be due to genetic differences. These differences in genetic endowment will not be concentrated in a single individual. Different leopards will have different strengths and weaknesses that aid them in hunting. However, those leopards that hunt and feed better, for whatever reason, will tend to live longer and reproduce more, thus passing on more copies of the genes that gave them their muscle mass, stamina, and vision. Notice that it is *reproduction* that really matters here—reproduction, not survival, is the gold standard of natural selection.

In the course of evolution, whatever genetic variation that exists in a population is run through a natural sieve. Environmental selection forces, such as the speed of impalas and the distance at which a leopard can identify an impala as a possible dinner source, are "selecting" which leopards will feed, survive, and, ultimately, reproduce, thus passing on their genes for greater speed, better vision, stamina, and all the other functional characteristics that leopards possess. Over many generations, this process will produce a population of leopards that are, on average, faster, have better sight, and so on.

As we discuss evolutionary explanations of violence, it is necessary to bear in mind that we are always talking about selection *in the past* for characteristics that humans display *today.* Selection has sculpted behavioral characteristics by "choosing" the genes that underlie a given behavior. But, genes do not code for behavior directly; instead, they code for the construction of all the different types of proteins of which an organism is composed. The mind-boggling complexity of an organism like yourself with your many interacting parts—your skin and heart and liver and brain—is made possible because your genes are making the different proteins that compose the cells of your skin, liver, heart, and brain that, in turn, compose you.

Of special importance to behavior is the fact that your brain, which controls your behavior, is constructed the way that it is because of genes. This genetic influence continues throughout your life. In fact, as you read this chapter, a cascade of neurological changes is taking place in you, among them the turning on of genes that help strengthen the connections between neurons that create new images and memories (Kandel, 2006). In a sense, you are constantly being rewired, all of which is made possible by your genes.

But, what about violence? What about a case like that of Joel Zellmer, who was arrested in 2007 for drowning his stepdaughter, Ashley McLellan, in his pool? According to court documents, Zellmer had a history of violence against the children of unwed mothers whom he had dated or been engaged to, including two previous nonbiological children who nearly drowned while with him and a third who suffered broken bones while under his care (Hagey, 2007; Johnson, 2007). However, none of his biological children were ever harmed (Johnson, 2007). The question for researchers working within the evolutionary tradition is this: Has our evolutionary history selected genetic variants that underlie this behavior? The challenge, in short, is to discover whether or not, and to what extent, violent behavior is under genetic influence. There are two broad research traditions evolutionary theorists engage in that attempt to address this issue.

Population Genetics and Violent Crime

Ever since the gene-based theory of evolution by natural selection was ushered in with what is called the *modern synthesis,* population genetics has been central to evolutionary biology. When evolutionary theorists observe some phenomenon among a natural population, like the elevated levels of violence among human males compared to females, they begin to ask whether or not this phenomenon might be an adaptation produced by natural selection. Population genetics is a mathematical tool that is used to see whether or not it is theoretically possible for hypothesized genes underlying a phenomenon (such as violence) to have spread in the population over multiple generations, under the influence of natural selection. In other words, the type of question that population geneticists are concerned with is this: If a particular genetic variant—called an *allele*—appears in a population, and if it has certain types of hypothetical effects, will it become more common in the population over time because of its selective advantage? The theorizing of criminologists who have been inspired by evolutionary theory has been greatly influenced by population genetics thinking.

If you think back to the examples at the beginning of this chapter, you will notice that all of the crimes depicted involved male offenders. This is neither unintentional nor unrealistic. Crimes of violence are overwhelmingly committed by men. Here are some relevant statistics to consider. In the United States in 2002, there were 9,015 men arrested for murder and nonnegligent manslaughter compared to 1,092 women; 19,884 men were arrested for forcible rape while only 278 women were; 69,369 men were arrested for robbery and women accounted for a mere 7,973 arrests; and, finally, 270,905 men were arrested for aggravated assault compared to 68,532 women (Pastore & Maguire, 2005). In sum, for violent crimes in the U.S. in 2002, men were nearly five times as likely to be arrested as women. This same general pattern is consistent across time and across societies.

The question is why would males dominate in the commission of nearly all types of offenses, not just in the United States but throughout the world? Using a population genetic style of reasoning, we can ask, Are there any reasons to believe that any genes in the population that increase male aggressiveness would become more common in males over time? When it comes to understanding the heightened levels of violence among males, population genetics thinking, as well as a specialized version of natural selection that Darwin (1859, 1871) referred to as *sexual selection,* have been particularly important.

Sexual selection theory says that just as the speed of impalas, for example, led to selection for characteristics that increased the speed of leopards, males and females in a population can select for characteristics of the other sex. So, for example, as females choose which males to mate with, they are choosing the genetically influenced characteristics of those males; those characteristics thus become more common in the population. These mating decisions can be thought of as cost/benefit choices, although the choices are largely unconscious. Particularly important to the unconscious calculation of mate choice is the amount of parental investment (time, effort, and resources) that each sex must make in order to produce offspring who will mature and go on to reproduce successfully themselves.

Robert Trivers (1972), who created the concept of parental investment, noted that "in the vast majority of species, the male's only contribution to the survival of his offspring is his sex cells. In these species, female contribution clearly exceeds male and by a large ratio" (p. 141). Human males, generally speaking, make a considerable investment in their offspring, but it is women, not men, who carry the developing offspring for nine months until birth. Trivers, like Bateman (1948) before him, realized that the sex that invests the most in offspring (usually females) will be more discriminating when it comes to mating. The sex that invests the least (usually males) will tend to favor quantity over quality of mates and will compete more intensely; that is, males will compete with other males to be chosen. Often accompanying this male-male competition will be intense aggression and risk taking.

Theorizing About Violent Crime

A number of criminologists operating in the evolutionary tradition have used the above lines of reasoning to produce theories of criminal behavior, with a special emphasis on violent offenses. They include David Rowe (1990, 1996), Linda Mealey (1995), and Lee Ellis (2003, 2004, 2005). Below is a basic sketch of arguments they have made in common:

> People, especially males, vary in their tendencies to invest time and energy in caring for offspring, and this variation is partly the result of genetic factors. In other words, some males appear to be biologically less inclined to devote time and energy to ensuring the welfare and happiness of their children.
>
> Males who want to invest heavily in parenthood are the sort of men most women would like to have father their children, so these men are called *dads*. The men who are not inclined to make this investment beyond the donation of sperm are referred to as *cads*.
>
> If evolutionary theory is correct, both types of males need to have offspring if their genes are to be represented in subsequent generations. This means that both dads and cads must find females with which to mate. Dads, of course, should have no trouble, but how can cads reproduce, given that females will avoid them? Here are some reproductive options for them:
>
> 1. Cads can use deception to secure mates, such as promising to stay loyal during the courtship process and then reneging after a female is impregnated.
> 2. Cads can intimidate and injure any rival males.
> 3. Cads can exaggerate their abilities to be a good provider, such as by stealing and cheating others out of resources.
> 4. Cads can use force to have sex when voluntary methods fail.

Are there cads "out there," and are their actions at least partly genetically programmed, as Rowe (1990, 1996), Mealey (1995), and Ellis (2003, 2004, 2005) have argued? And are cads more involved in crime than are other males? The short answer to these questions is as follows: There is a psychiatric condition known as *psychopathy* or *antisocial personality* that is almost exclusive to males (Cottler, Price, Compton, & Mager, 1995; Mulder, Wells, Joyce, & Bushnell, 1994), and genes appear to contribute to this condition (Crowe, 1974). Furthermore, psychopaths are more likely than males generally to be involved in crime (Ellis & Walsh, 2000, p. 17), and they tend to be extremely deceptive, manipulative, cruel, and violent (Hare, Harpur, Hakstian, Forth, Hart, & Newman, 1990).

Theorizing About Specific Types of Violent Crime

In addition to the broad-ranging evolutionary/genetic theories of criminality just described, there are other theories of a similar nature that have been applied to specific types of violent offenses. The most extensive investigations into the possible evolutionary underpinnings of criminal violence have been conducted by Martin Daly and Margo Wilson (1985, 1988, 1994; Wilson, Daly, & Weghorst, 1980).

One focus of their work has been the study of child abuse by parents, such as the case of Joel Zellmer that we described earlier. In *The Truth about Cinderella,* Daly and Wilson (1999) point to studies that have shown that adults are much more likely to injure stepchildren than they are any biological children they may have. In evolutionary terms, this can be explained by noting that far fewer genes are shared between adults and stepchildren than between adults and their biological children. In other words, from an evolutionary perspective, individuals who harm close genetic relatives are less likely to pass genes on to future generations than are individuals who harm distant relatives or nonrelatives. This is not to assert that violence does not occur between close genetic relatives, and it certainly does not serve to condone any form of child abuse. The work by Daly and Wilson indicates that, given the same opportunities in terms of time spent together, genetically unrelated persons will be substantially more violent to each other than will those who are close relatives (Ellis & Walsh, 1997, p. 242).

In discussing their findings, Daly and Wilson (1999) were quick to note the obvious: Most stepparents do not harm or hurt their stepchildren. Nevertheless, there is a highly elevated probability of their doing so compared to biological parents, and this is quite consistent with predictions derived from evolutionary theory.

Another line of investigation by Daly, Wilson, and Weghorst (1982) involved spouse abuse. Evolutionary reasoning caused them to predict that much spouse abuse is motivated by infidelity (or suspicions of infidelity). Males, in particular, have difficulty knowing which offspring are theirs, except by inferring parenthood if they have maintained exclusive sexual relations with the offspring's mother. Because helping to rear the offspring of another male will be strongly disfavored from an evolutionary standpoint, males should strenuously act to prevent their mates from being sexually involved with other males. Daly and Wilson (1996) believe that this helps to explain why sexual jealousy has been shown to be the single most common "cause" of spousal abuse. Theoretically, violence toward spouses, especially by males, may represent part of an evolved response to male risks of misdirecting their so-called "parental investment" to the offspring of some other male. This explanation does not justify spouse abuse, but it may offer a way to understand why it is so common throughout the world, and it may eventually help to develop preventive strategies.

Another realm of criminological investigation using evolutionary/genetic principles concerns rape (or sexual assault). In the 1980s, various evolutionary thinkers began to entertain the idea that because males, compared to females, make such minimal direct investment in producing offspring, they should be more eager to copulate. Some males may even carry their "eagerness" so far that they sometimes resort to force if they are unsuccessful at securing voluntary compliance (Thornhill & Thornhill, 1983; Ellis, 1991a; Thornhill & Palmer, 2000). From a biological standpoint, these males may stand to father more offspring than males who do not use forceful tactics, and thereby their genes will be better represented in future generations. While any number of social countermeasures may be advanced to combat rape, it has even been suggested that rapists should be imprisoned throughout most of their reproductive years.

In sum, there are strong selective and population genetics reasons to expect that violent behavior, particularly among young men, is part of our evolutionary legacy. But is there more direct evidence of genetic influences on criminal violence?

Show Me the Genes!

If evolutionary theory can help to explain violent criminal behavior, genes *must* be making a significant contribution to the variations in such behavior. In other words, no trait can evolve by natural selection if genes are not at least partly responsible for the trait. This means that some people must be more genetically predisposed to act in ways that are defined as criminal than are other people. In order to explore this possibility, researchers use two different approaches: behavioral genetics and molecular genetics.

Is there evidence for any specific genes contributing to criminality, especially violent criminality? Behavioral genetics research, which is often based on so-called twin studies and adoption studies, has allowed scientists to separate genetic and environmental influences on traits. While the actual percentage estimates vary from 35% (van der Valk et al., 1998) to as much as 80% (Dionne, Tremblay, Boivin, Laplante, & Perusse, 2003), nearly all studies agree that the role of genetics in affecting tendencies toward aggression and violent crime is substantial.

So, what specific genes seem to be involved? In order to address this question, researchers engage in *molecular genetics* studies, which seek to isolate specific genes and identify their effects. Scientists now estimate that the development of each human is guided by approximately 22,000 genes located on our 23 pairs of chromosomes. However, we are a long way away from identifying what each of those genes does in terms of building and regulating our bodies. It is safe to assume that many of these 22,000 genes code for vital structures and processes in our brains, which, in turn, affect how we react to the experiences we have every day. Progress is being made in identifying how these genes work and thereby affect the probability of our behaving in ways that violate criminal statutes.

Four instances of how genes seem to affect our probability of engaging in criminal violence will be briefly described here. You will see that in one way or another, all four examples involve the brain's neurotransmitters, biochemicals that send messages from one nerve cell to another and make it possible for us to think and carry out complex activities.

1. For over a decade, scientists have been intrigued by an unnamed Dutch family, in which some extremely disturbing behavior was found among many of the men (Brunner, Nelen, Breakefield, Ropers, & van Oost, 1993; Brunner, Nelen, van Zandovoot et al., 1993). One of the men attempted to rape his sister and later assaulted a prison warden with a pitchfork. Others in the family had committed arson, assaults on both men and women, and had made numerous threats with weapons. In total, 14 male members of this family over four generations have committed numerous violent acts while also exhibiting mild mental retardation.

What drew scientists to study this family was the discovery that the affected men had an unusual version of a gene controlling an enzyme that helps break down important neurotransmitters, an enzyme known as monoamine oxidase. This family suffered from a particularly rare mutation in this gene that essentially eliminates the production of one form of monoamine oxidase (known as MAO-A). Several other studies have implicated variants of genes regulating monoamine oxidase activity as a contribution to criminal behavior, at least among males (Ellis, 1991b; Sjoberg et al., 2008).

In a recent New Zealand study, a gene coding for low MAO-A activity was found to be associated with violent and antisocial behavior if individuals also suffered substantial maltreatment as children. Individuals with the same genetic variant but who were not abused as children were not unusually prone to antisocial conduct (Caspi, McClay, Moffitt, Mill, Martin, & Craig, 2002). The researchers interpreted this finding as suggesting that both genetic and family environmental factors must often interact to affect criminality. Overall, this line of research on MAO-A suggests that the way genes alter the breakdown of neurotransmitters may help in the understanding of antisocial behavior.

2. Another line of research has pointed to genes regulating *dopamine,* an important neurotransmitter associated with the pleasurable and rewarding experiences that people gain from activities ranging from having sex to using drugs such as cocaine and alcohol. At a genetic level, there are several alleles (i.e., various forms of the same gene) that code for different types of dopamine receptors (i.e., special locations on nerve cells that lock onto dopamine molecules).

In recent years, at least two of these special types of dopamine receptors (DRD2 and DRD4) have been found to be associated with an increased risk of criminality and/or closely related behaviors such as alcoholism, drug abuse, and antisocial personality disorder (Comings, Muhleman, Ahn, Gysin, & Flanagan, 1994; Noble, Ozkaragoz, Ritchie, Belin, & Sparkes, 1998), although not all of the research has been able to replicate these links (Lee, Lee, Kim, Kim, & Lee, 2003). A recent article may help to explain the inconsistencies. It suggested that certain forms of genes for *both* DRD2 and DRD4 may have to be present before these receptors alter dopamine brain activity enough to promote behavioral traits conducive to criminal offending (Beaver et al., 2007).

3. Genes that influence another neurotransmitter—serotonin—have also been found to be related to criminal violence. Elevated levels of serotonin activity in the brain are associated with feelings of calm and contentment; low levels are associated with irritability and gloom. Studies have shown that impulsive violence is more common in persons with low levels of serotonin activity (Blumensohn et al., 1995; Coccaro, 1992; Virkkunen, Eggert, Rawlings, & Linnoila, 1996). While there are many environmental variables involved in regulating how active serotonin is in the brain (including some of the foods we eat), most of the variation appears to be due to genetic factors (Greenberg, Tolliver, Huang, Li, Bengel, & Murphy, 1999; Heinz et al. 2005; Liao, Hong, Shih, & Tsai, 2004). The message from this line of research seems to be that violence can be avoided by somehow keeping serotonin levels in our brains high.

4. The final line of evidence for genetic influences on violent criminality may help criminologists understand sex differences in criminal violence. Males have an entire chromosome that females lack: the Y-chromosome. Located on this chromosome are genes that direct would-be female ovaries

to become male testes instead. The testes have evolved into specialized organs for producing testosterone, a hormone that has been shown in many species to contribute in complex ways to physical aggression (Jasnow, Huhman, Bartness, & Demas, 2000; Sanchez-Martin, Fano, Ahedo, Cardas, Brain, & Azpiroz, 2000). The tendency to behave aggressively is not simply a matter of how much testosterone is present in the body at a given point in time, however. It also depends on how much testosterone gets into the brain even before birth and how many special cell receptors (called *androgen receptors*) are present in the brain to lock onto each testosterone molecule that enters (Lundin, Nordenskjold, Giwercman, & Giwercman, 2006). As with testosterone production itself, the number of androgen receptors individuals possess appears to be under considerable genetic control (Jorm, 2004; Sluyter, Hof, Ellenbroek, Degen, & Cools, 2000).

How does testosterone affect physical aggression tendencies, including those that are considered criminal? The answer is complex, but part of it has been shown to involve the ability of testosterone to influence neurotransmitter functioning, including both dopamine and serotonin (Guo, Roettger, & Shih, 2007; Miczek, Fish, de Bold, & de Almeida, 2002).

Noting that testosterone affects the probability of criminal violence, one can infer that males are going to be more involved in crime, especially violent crime, than are females. Reinforcing the view that evolution is at least partly responsible for this sex difference is evidence that in nearly all mammalian species, males are more prone to violence than are females (Ellis et al., 2008, pp. 705–709).

Conclusion

The ideas outlined in this chapter are part of an approach to criminology known as *biosocial criminology.* According to this approach, both biological and social environmental factors interact to affect people's probabilities of violating criminal statutes. In other words, criminological theories that only stipulate the involvement of environmental factors may be true, but they are incomplete. In fact, environmental factors are dependent upon genes to have their effects. As Matt Ridley (2003) notes,

> [genes] are devices for extracting information from the environment. Every minute, every second, the pattern of genes being expressed in your brain changes, often in direct or indirect response to events outside the body. Genes are the mechanisms of experience. (p. 248)

Ridley here is referring to the role of genes in *development*—the characteristics that are expressed in an organism over the course of its lifetime. In the biosocial approach, characteristics like violence and aggression can only be fully understood by considering the interaction of genes and environment in their production.

However, the genes that are operative in development have been selected for over evolutionary time. In effect, natural selection chooses among alternative developmental pathways, and our evolutionary history has established a species-typical developmental trajectory for humans. Part of that species-typical trajectory involves the capacity to behave in aggressive and violent ways. While genes and environment interact to produce violent behavior in any individual case, it is our evolutionary history that explains the quite stable and predicable patterns of violent and aggressive behavior more generally, that is, the universally higher rates of violence among young men.

While the things that we do not know about how evolution and genes have influenced aggression and criminality are immense, as the literature discussed in this chapter has shown, progress is being made. The ultimate payoff for our knowledge will come when it helps to reduce the number of victims who suffer violent offenses every year.

Discussion Questions

1. Describe the process of natural selection.
2. Discuss the different roles that genes play in evolution and in development. Discuss their relationship to population genetics research as well as behavioral and molecular genetics research.
3. What is "sexual selection" and how is it related to violent behavior?
4. Some specific genes have been identified as being related to violent behavior. In general, how do these specific genes influence violent behavior?
5. Discuss the moral and political issues that are raised by our increasing knowledge of genetic influences on violent behavior.

Internet Resources

British Psychological Society, Forensic Research Update: http://bps-research-digest.blogspot.com/search/label/Forensic

Crime Causation: Biological Theories: http://law.jrank.org/pages/795/Crime-Causation-Biological-Theories.html

Human Genome Project: http://www.ornl.gov/sci/techresources/Human_Genome/home.shtml

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