Beaver, K. M. (2019). Biosocial Criminology: A Primer. Kendall Hunt Publishing Company

found to be associated with differential activation of the prefrontal cortex during tasks that demand the use of executive functions,[32] during decision-making processes,[33] and during the activation of working memory.[34] The *MAOA* gene has also been linked to brain function as well as brain structure. A study conducted by Andreas Meyer-Lindenberg and colleagues found that the low *MAOA* activity allele (the same allele that has been linked to antisocial phenotypes; see Chapter 2) was associated with reduced limbic volume, greater amygdala activation, and reduced prefrontal cortex activity.[35] For males, *MAOA* genotype was also associated with orbitofrontal volume and activity levels in the amygdala and hippocampus. Taken together, these genetic-imaging studies provide empirical support, linking certain polymorphisms to variation in brain structure and function. In the next section, we explore whether variation in the structure and functioning of the brain is linked to antisocial phenotypes.

The Brain and Antisocial Phenotypes

The neuroimaging techniques described above have been used to test the connection between the structure and function of the brain and antisocial phenotypes. In these studies, researchers typically compare the brains of a group of offenders to the brains of a control group. The brains of these two groups are then analyzed to determine whether there are any differences (either structural or functional differences depending on the neuroimaging technique used). When a difference is detected, the conclusion usually drawn is that there is an association between the brain and antisocial behavior. This approach has been employed in an impressive amount of research to examine whether brain structure and functioning are related to a range of antisocial phenotypes from murder to pathological lying.[36] The following discussion, however, will focus on only two broad groups of offenders: murderers and psychopaths.

Adrian Raine and his colleagues conducted the first study to use neuroimaging techniques to explore brain functioning in murderers.[37] They scanned the brains of 22 murderers who pleaded not guilty by reason of insanity and compared them to the brains of 22 nonmurderers who were matched on sex and age. The results of the PET scans revealed that murderers, in comparison with the control group, had lower metabolic activity in the prefrontal cortex. Another study, also conducted by Adrian Raine, compared the brain structure and function of 41 murderers who pleaded not guilty by reason of insanity to 41 nonmurderers matched on age and gender.[38] Once again, the PET scans indicated that the murderers had reduced metabolic activity in the prefrontal cortex as well

as the corpus callosum and areas of the brain implicated in behavioral regulation. They also reported structural differences in the amygdala, thalamus, and medial temporal lobe between the murderers and the control group.

The next study published by Adrian Raine examined brain functioning in a sample of 15 predatory murderers, 9 affective murderers, and 41 controls.[39] Predatory murderers, generally speaking, are murderers who proactively seek out their victims and murder in cold blood. Affective murderers, in contrast, are murderers who are hot-headed and impulsive and typically murder in an act of rage. Raine and colleagues hypothesized that affective murderers, in comparison with predatory murderers, would have lower prefrontal cortex activity and higher limbic system activity. They speculated that an overactive limbic system would produce intense emotions, such as rage and anger, while an underactive prefrontal cortex would be less able to control these emotions. For example, suppose someone insulted you. You most likely would be angry, but your prefrontal cortex typically prevents you from acting on this rage. Pretend, however, that your limbic system was overly active. Now, this insult would produce even more intense anger and rage. And also pretend that your prefrontal cortex was not as active and thus was not as able to control your anger and rage. This is precisely the type of situation that would lead to affective murders. Predatory murder, however, requires planning and forethought, which necessarily means that predatory murderers should not have deficits in the prefrontal cortex. The results of the PET scans largely substantiated this hypothesis, where affective murderers, in contrast to predatory murderers and controls, had generally lower prefrontal cortex activity, while having higher limbic system activity.

These studies provided strong evidence that brain structure and function are associated with murder, but as Chapters 2 and 3 made clear, the environment is also important in the emergence of violent behaviors. Adrian Raine et al. took this into account by examining brain functioning in two groups of murderers: those who were reared in criminogenic environments (e.g., abuse and neglect) and those who were reared in "normal" environments.[40] This research team then compared the brain functioning of these two groups. The results were quite striking: murderers reared in normal environments had lower prefrontal cortex activity in comparison with murderers who were reared in criminogenic environments. Raine and colleagues speculated that criminogenic environments can produce violent offenders in the absence of biological predispositions. Persons reared in noncriminogenic environments, however, need a biological predisposition to become a violent offender. In this way, Raine's research emphasizes the importance of biology and the environment in the understanding of violent offending.

A number of studies have also used neuroimaging techniques to examine the brain structure and function of psychopaths. Psychopaths are among the most serious violent and dangerous offenders. They lie, steal, cheat, rape, rob, and otherwise prey on society. They are often described as lacking empathy, being egocentric and narcissistic, and they are pathological liars. Although estimates vary as to the prevalence of psychopathy, research tends to indicate that psychopaths are overrepresented in prisons and they are disproportionately involved in the most violent crimes. This group of offenders thus represents some of the worst offenders.[41]

Brain-imaging researchers have analyzed samples of psychopaths and, similar to murderers, have found structural and functional impairments in the prefrontal cortex.[42] Raine and colleagues, for example, reported an 11% reduction in gray matter volume in the prefrontal cortex of 21 psychopaths in comparison with two control groups.[43] Other studies have detected functional differences in the prefrontal cortex of psychopaths, where metabolic activity in the prefrontal cortex tends to be lower in psychopaths than in controls.[44] Recently, Sarah Gregory and her colleagues used structural MRI techniques to examine the potential association between structural gray matter and psychopathy in a total of 66 men.[45] The results of their analyses revealed significant reductions in gray matter volumes in the prefrontal cortex of psychopaths when compared to nonoffenders. Similar results were reported in an innovative study conducted by Yaling Yang et al. In this study, Yang and colleagues examined prefrontal gray matter volume in a sample of 16 unsuccessful psychopaths (i.e., they were caught and convicted of a crime), 13 successful psychopaths (i.e., they were not caught for their criminal behaviors), and 23 controls. MRIs revealed that unsuccessful psychopaths, in comparison with the control group, had reduced prefrontal gray matter in the prefrontal cortex. There was no difference in gray matter volume between successful psychopaths and the control group. The results of this study were explained by Yang and colleagues in the following way:

> Relatively intact prefrontal structure may provide successful psychopaths with both the cognitive resources to manipulate and con others successfully, as well as sufficiently good decision-making skills in risky situations to avoid legal detection and capture. In contrast, prefrontal structural deficits may render unsuccessful psychopaths particularly susceptible to poor decision making; interpersonally inappropriate, impulsive, disinhibited, unregulated, reward-driven antisocial behavior; and reduced sensitivity to environmental cues signaling danger and capture–factors placing them more prone to legal detection and conviction.[46]

In a different study, Raine's research team also used neuroimaging techniques to examine the structure and function of the corpus callosum in psychopaths.[47] Compared to controls, psychopaths had a 22.6% increase in white matter volume in the corpus callosum and a 6.9% increase in length, yet had a 15.3% reduction in the thickness of the corpus callosum. Why the corpus callosum is different in psychopaths is not known, but it appears as though the structural differences in psychopaths' corpus callosum may reflect some type of neurodevelopmental abnormality.

Neuroimaging studies have also detected structural and functional differences between psychopaths and nonpsychopaths in the limbic system. For example, fMRIs have indicated that psychopaths, when compared to nonpsychopaths, have reduced activity levels in the amygdala and in the hippocampus.[48] In addition to these functional differences, studies have also revealed structural differences in the hippocampi[49] and amygdala of psychopaths.[50] For instance, Raine's research team reported a 17.1% to 18.9% reduction in the volume of the amygdala.[51]

Also of relevance are two additional neuroimaging studies that did not examine samples of psychopaths per se, but did examine behaviors that are common among psychopaths. In the first study, Yaling Yang and colleagues used MRIs to examine brain structure in a sample of 12 pathological liars and two control groups.[52] The results of their imaging analysis revealed that pathological liars, in comparison to subjects from the control groups, had increased white matter volume. The precise reasons for this relationship are not well understood, but it may be the case "that increased prefrontal white matter developmentally provides the individual with the capacity to lie."[53] In the second study, brain functioning was examined in a sample of spouse abusers. fMRIs indicated that spouse abusers, in comparison with nonspouse abusers, had more active limbic systems and less activity in the prefrontal cortex. According to the study authors, "The findings give rise to the provisional hypothesis that when exposed to aggressive stimuli, batterers have inadequate prefrontal resources to exercise top-down regulatory control over the excessive limbic activation generated by negative stimuli."[54]

Collectively, the results of these neuroimaging studies provide strong empirical evidence supporting speculation that brain structure and brain function are associated with antisocial phenotypes, especially violence and psychopathy or psychopathic personality traits.[55] More specifically, the findings across these studies consistently revealed that compared to noncriminals, criminals had reduced activity in the prefrontal cortex and increased activity in the limbic system. These findings largely substantiate the claim that antisocial phenotypes are partially the result of an underactive prefrontal cortex and an

overactive limbic system. We next turn to a discussion of how the brain can be integrated into criminology by showing its application to two of the most studied crime correlates: age and gender.

Applications to Criminology

Two of the strongest predictors of criminal and delinquent involvement are age and gender. In almost every sample, regardless of the country of origin and the historical time period, adolescents and males are overrepresented in acts of crime, especially in acts of serious violence.[56] Although numerous explanations have been advanced to explain the relationship between age and crime and the relationship between gender and crime, very little is known about how age and gender are linked to antisocial phenotypes, including crime. Below, a rough sketch is presented showing that integrating the brain into criminology can provide some much-needed insight into how and why age and gender are associated with antisocial outcomes.

Age and crime. One of the most robust correlates to antisocial behavior is age. Across virtually every study, age emerges as a statistically significant predictor of criminal and delinquent involvement. Research findings have indicated that delinquent behavior ceases to exist until around the age of 12 or 13 where it begins a sharp and steady incline. During adolescence, almost all youth engage in at least minor forms of delinquency, such as petty theft and underage drinking. By around the age of 18 or 19, the prevalence of delinquency begins a very sharp downward trend so that by the mid- to late 20s, most people have "aged out" of crime and no longer are delinquent. This general age-graded pattern of offending has been dubbed the "age–crime curve." Although much criminological scholarship has been devoted to studying and trying to explain the age–crime curve, criminologists have been unable to provide any "hard-and-fast" evidence on the causes of this phenomenon. But, as some biosocial researchers have pointed out, the brain may be the key to unlocking the underlying mechanisms that can explain the age–crime curve.[57] To understand how, let us explore brain development, paying particular attention to the adolescent brain.

Adolescents are, on average, poor decision makers. They skip school, use drugs, engage in unsafe sexual practices, drive recklessly, participate in delinquency, and so on.[58] Numerous explanations have been advanced to explain these behaviors, ranging from peer pressure to the need for autonomy. While each of these explanations may hold a kernel of truth, they all fall short of providing a full-blown (and believable) account of why

adolescents are more troublesome, aggressive, and impulsive than any other age-group. Recently, however, neuroscientific research has provided a compelling account for these age-graded behaviors: the brain.

Brain-imaging techniques have been used to plot the development of the brain from childhood through adulthood. The results of these studies have indicated that brain development does not commence during childhood or adolescence as once was believed, but instead continues to develop well into adulthood. At the onset of puberty, the adolescent body and brain are flooded with chemicals and hormones, including testosterone, that stimulate certain parts of the brain, such as the amygdala. This is why adolescents may be calm and complacent one moment and yelling and screaming the next. But it is not just the influx of these biochemicals that explains youthful misconduct; the brain is also changing structurally. In particular, the limbic system, where emotions and feelings are generated, is fully developed by adolescence. Sex hormones (i.e., testosterone and estrogen) are overly active in the limbic system. What this means is that with the sudden influx of biochemicals, the limbic system is working overtime.

Usually, the emotions flowing from the limbic system are controlled by the prefrontal cortex. But, guess what? The prefrontal cortex is not fully developed in adolescents; in fact, it does not finish developing until the mid- to late 20s. This means that adolescents have an overactive limbic system (due to the surge of hormones) superimposed on a prefrontal cortex that is not structurally developed, all of which amounts to a recipe for disaster.[59] Perhaps Richard Restak, the eminent neurologist, said it best when he said that "the immaturity of the adolescent's behavior is perfectly mirrored by the immaturity of the adolescent's brain."[60] Some sociological criminologists are even finding it difficult to ignore the importance of the brain any longer. For example, Michael Benson, who is a sociologist by training, recognized the importance of the brain in adolescent delinquency when he opined the following:

> The teenage brain has a lot to do with teenage delinquency. When it comes to managing their behaviors, teenagers lack more than just experience and education; they also lack some of the mental equipment necessary to make sound judgments and to act responsibly. At the outset of the teenage years, our emotional inner life takes on a vividness that we have never experienced before and that our brain is not yet fully ready to handle. From a developmental perspective, the misperceptions, bad decisions, and emotional overreactions of teenagers are to a certain degree biologically programmed. Conformity is simply more difficult for teenagers than adults.[61]

Adolescent delinquency typically passes as quickly as it emerged. By the mid- to late 20s, criminal and delinquent involvement is almost nonexistent. Perhaps not coincidentally, this is about the same age range in which the prefrontal cortex finishes developing. The prefrontal cortex, in other words, finishes maturing around the same age that criminal and delinquent involvement drop off considerably. The findings from neuroimaging studies thus hint at the very real possibility that brain development may be the answer to the elusive question of what accounts for the relationship between age and crime.

The adolescent brain and the adult brain are not only different structurally but they are also different neurochemically. In comparison with the adult brain, the adolescent brain has different baseline levels of certain neurotransmitters, some of which have been linked to antisocial phenotypes. Levels of serotonin (a neurotransmitter thought to inhibit criminal behavior; see Chapter 2) increase with age, which necessarily means that concentrations of serotonin are lower in adolescents than in adults. Moreover, norepinephrine and dopamine, both of which are thought to facilitate antisocial behaviors, are found at relatively higher levels in adolescents than in adults. Perhaps part of the reason why adults are better than adolescents at controlling their impulses and thus regulating their behaviors is because their levels of serotonin are higher, while their norepinephrine and dopamine levels are lower.[62] This remains pure speculation; however, because empirical research has yet to examine whether the age-graded fluctuations in these neurotransmitters are able to explain the age-graded fluctuations in delinquent and criminal behavior. Nonetheless, the neuroscientific research discussed above provides a new and refreshing explanation for why there is such a strong, consistent, and robust association between age and crime.

Sex and crime. A brute fact flowing from criminological research is that males are much more likely to engage in crime, especially violent crime, than are females. This sex effect has been observed in every country ever studied and at every time period.[63] Still, what causes males to be overrepresented in violence and aggression remains unknown. One of the more common explanations advanced by sociological criminologists is that males and females are socialized differently. According to this line of reasoning, males are socialized to be dominant, assertive, aggressive, and violent. Females, in contrast, are socialized to be passive, docile, loving, empathetic, and caring. As a result of these different socialization patterns, males turn out to be more violent and criminal, while females turn out to be more coddling and affectionate. In keeping with their academic training, sociological criminologists also argue that biology plays virtually no role in creating

these gender differences. The prevailing consensus among sociological criminologists, then, is that male–female differences in antisocial behavior are the result of differential socialization, not differences in biology. There is a problem with this explanation: there is not a shred of evidence to support it.

Consider, for example, the argument that culture shapes behavior, including criminal behavior. If this is true, then why are males more violent than females in every society ever studied? Surely, there should be some places where males are socialized to be passive and demure, while females are socialized to be aggressive and violent. This simply is not the case. Males are always and everywhere more violent and aggressive than females.[64] Still, sociological criminologists cling to their sociological roots and argue that boys and girls are socialized differently, and these socialization differences are what ultimately produce gender disparities in crime. For instance, there is a general belief that cultural factors are partially (or largely) responsible for producing male–female differences in criminal behavior. One of the key reasons for why this explanation has had so much clout is because of Margaret Mead's research that was conducted in the 1920s and 1930s. During this time, Mead began exploring the role that various cultures had on sex-specific behavioral patterns. The capstone to her research was published in the highly influential book, *Sex and Temperament in Three Primitive Societies*.[65] Among other things, this book showcased that culture was responsible for shaping males and females differently. The findings reported in her book purportedly destroyed explanations that relied on biological factors to explain male–female differences in behavior.

Although Mead's research went relatively unchecked and was consumed as being factual in nature, critiques of her work slowly began to emerge.[66] Perhaps the most scathing attacks of her research came from Derek Freeman.[67] Freeman believed that Mead was embedded in cultures that she did not fully understand and, as a result, her conclusions about the culture were not necessarily accurate. This was particularly salient for her work on Samoan culture, wherein Mead interviewed and talked with Samoan women even though Mead herself was not fluent in their native language. What ultimately happened, according to Freeman, was that Mead misinterpreted jokes told by the Samoan women as being factual. She then melded together these "facts" into her analyses of cultural effects on behavior that ultimately formed the backbone of some of her major books, such as *Coming of Age in Samoa*.[68] Freeman's allegations have been substantiated by some of the women that were part of Mead's research. As a result, there is a good reason to believe that much of Mead's research was incorrect and thus should not be taken seriously and should certainly not be used to support the claim that culture is the dominant factor in producing male–female differences.

In addition to focusing on cultural influences, sociological criminologists also believe that parental socialization is at the heart of the reason for why males and females are different. According to this perspective, parents tend to socialize males differently from females and it is these differences in socialization that are responsible for making males more violent and criminal than females. The question, of course, is whether there is any empirical evidence to support this claim? Well, Hugh Lytton and David Romney set out to answer this question by examining whether parents actually socialize boys differently than girls.[69] To do so, they conducted a meta-analysis of 122 studies that had analyzed parental socialization in children. They looked at 19 different dimensions of parental socialization including physical punishment, discouragement of aggression, and warmth, nurturance, and responsiveness. The results of their meta-analysis revealed that only one dimension of parental socialization—the encouragement of sex-typed activities—was significantly different between boys and girls. In another, more recent meta-analysis, Joyce Endendijk and colleagues[70] also conducted a meta-analysis to examine sex-differentiated parenting by focusing on parental controls. In line with the findings of the previous meta-analyses, their analysis of 126 observational studies revealed only minimal differences in the parenting of boys versus girls. Taken together, the results of these meta-analyses are decimating to criminological theories that argue that the environment, including the family environment, is responsible for producing male–female differences in criminal involvement.

Criminologists have shied away from exploring the possibility that the brain may be able to explain the gender gap in offending behaviors. Part of the reason is because criminologists are not trained in neuroscience, and part of the reason is because it is a political minefield to talk of gender-based brain differences. Just ask Larry Summers. In 2005, he stated that there are neurobiological differences in the brains of males and females. Even though his statements were grounded in empirical evidence, he was forced to resign from his position as president of Harvard University, largely because his statements went against what is considered politically correct when it comes to talking about male–female differences. As was pointed out in Chapter 1, however, scientific knowledge is accumulated by exploring all hypotheses, not just those that are politically correct or dovetail with the current ideology. With that said, it is interesting to learn that there is a considerable amount of research indicating that the brains of males and females are structurally and functionally different.[71] These differences, in turn, may be able to account—at least in part—for the overrepresentation of males in violent, aggressive, and antisocial phenotypes. Although morphological differences have been detected on various regions of the brain, we will focus on differences in the limbic system and differences in the prefrontal cortex.

Not surprisingly, structures in the limbic system, including the amygdala[72] and the hypothalamus,[73] are relatively larger in males than in females, and these size differentials may partially explain why males are more likely to react to negative stimuli with physical violence.[74] Functional differences between males and females have also been observed for the amygdala. One study, for example, examined amygdala activity levels via PET scans. The results revealed that different regions of the amygdala were more active in males versus females and vice versa.[75] Neuroscience research has also explored gender-based differences in the prefrontal cortex. The results of these studies have revealed that females, on average, have relatively larger prefrontal cortexes than do males. But it is not just the size that matters; females also have greater activity levels in the prefrontal cortex, including the OFC.[76] In a more recent study examining gray matter volume differences between males and females, females were shown to have greater gray matter volume in the prefrontal areas of the brain whereas males were shown to have greater gray matter volume in structures from the limbic system, such as the amygdala and the hippocampus.[77] Taken together, the neuroscience research shows that males, when compared to females, have relatively larger limbic system structures coupled to a relatively smaller prefrontal cortex, which, according to some neuroscientists, "may explain gender differences in emotional behavior, particularly aggression."[78]

There is also some evidence indicating that levels of neurotransmitters are different between genders. Females tend to have higher levels of whole blood serotonin[79] and they also tend to have more serotonin receptors[80] than males. This is particularly important because remember that high levels of serotonin have been found to reduce antisocial phenotypes (see Chapter 2). Another neurotransmitter, γ-aminobutyric (GABA), also thought to inhibit violence and aggression, is found at higher concentrations in females.[81] Interestingly, there is some evidence to indicate that dopamine, a neurotransmitter thought to facilitate antisocial behaviors, is found at lower, not higher, levels in males than females.[82] It remains to be seen whether these male–female differences in neurotransmitter levels are able to account for sex and gender differences in criminal offending.

Summary

This chapter took us on an exploration of the brain and discussed the various ways in which the limbic system and the prefrontal cortex may contribute to the development of antisocial phenotypes. The limbic system is where emotions, such as anger, fear, and rage, are generated. The prefrontal cortex is responsible for controlling the emotions engendered by the limbic system and the prefrontal cortex is also responsible for the so-called executive

functions such as planning, judgment, and behavioral regulation. Neuroimaging research suggests that criminals suffer from an overactive limbic system and from an underactive prefrontal cortex. There is also reason to believe that the brain may be able to explain, at least in part, the age–crime curve and male–female differences in aggression and violence. These are exciting possibilities and ones that hopefully encourage criminologists to seek out additional ways that the brain may be involved in the development of antisocial phenotypes.