In February of 1991, Stephen Mobley walked into a Domino’s Pizza store in Georgia to rob it. After getting the money, Mobley forced store manager John Collins onto his knees and shot him execution style. After committing several other robberies and bragging to friends about Collins’ murder, Mobley was apprehended by Atlanta police, charged with aggravated murder, and sentenced to death. In the automatic appeal to the Georgia Supreme Court to get his sentenced commuted to life in prison, his primary defense boiled down to claiming that his “genes made [him] do it.” In support of this defense, Mobley’s lawyers pointed to a Dutch study of an extended family in which, for generations, many of the men had histories of unprovoked violence. The Researchers took DNA samples from 24 male members of the family and found that those with violent records had a marker for a mutant or variation of a gene for the manufacture of monoamine oxydase (MAO), an enzyme that regulates a lot of brain chemicals. Mobley’s lawyers found a similar pattern of violent behavior and criminal convictions among his male relatives across the generations and asked the court for funds to conduct genetic tests on Mobley to see whether he had the same genetic variant.

The court wisely denied the defense motion. Even if it were found that Mobley had the same genetic variant, it would not show that he lacked the substantial capacity to appreciate the wrongfulness of his acts or to conform to the requirements of the law. Mobley’s lawyers were hoping to mitigate his sentence by appealing to a sort of genetic determinism that simply does not exist. As we shall see in this section, genes don’t “make” us do anything; they simply bias us in one direction rather than another. Except in cases of extreme mental disease or defect, we
are always legally and morally responsible for our behavior. Cases such as Mobley’s underline the urgent need for criminologists to understand the role of genes in human behavior as that role is understood by geneticists.

Biosocial criminologists believe that because humans have brains, genes, hormones, and an evolutionary history, they should integrate insights from the disciplines that study these things into their theories and dismiss naïve nature versus nurture arguments in favor of nature via nurture. Any trait, characteristic, or behavior of any living thing is always the result of biological factors interacting with environmental factors (Cartwright, 2000), which is why we call modern biologically informed criminology biosocial rather than biological. Biosocial approaches have three broad complementary areas: behavior genetics, evolutionary psychology, and neuroscience.

**Behavior Genetics**

Behavior genetics is a branch of genetics that studies the relative contributions of heredity and environment to behavioral and personality characteristics. Genes and environments work in tandem to develop any trait—height, weight, IQ, impulsiveness, blood sugar levels, blood pressure, and so on—the sum of which constitutes the person.

Behavior geneticists stress that genes do not cause us to behave or feel; they simply facilitate tendencies or dispositions to respond to the environments in one way rather than in another. There are no genes “for” criminal behavior, but there are genes that lead to particular traits such as low empathy, low IQ, and impulsiveness that increase the probability of criminal behavior when combined with the right environments.

Behavior geneticists use twin and adoption studies to disentangle the relative influences of genes and environments, and they tell us that genes and environments are always jointly responsible for any human characteristic. To ask whether genes or environment is most important for a given trait is just as nonsensical as asking whether height or length is most important to the area of a rectangle. Geneticists also tell us that gene expression depends on the environment (think of identical rose seeds planted in an English garden and in the Nevada desert, and then think about where the full potential of the seeds will be realized).

Behavior geneticists quantify the extent to which genes influence a trait with a measure called heritability (symbolized as $h^2$), which ranges between 0 and 1. The closer $h^2$ is to 1.0, the more the variance in a trait in a population, not in an individual, is due to genetic factors. Since any differences among individuals can only come from two sources—genes or environment—heritability is also a measure of environmental effects ($1 - h^2 = \text{environmental effects}$). All cognitive, behavioral, and personality traits are heritable to some degree, with the traits mentioned in the psychosocial section being in the .30 to .80 range (Carey, 2003).

Heritability estimates only tell us that genes are contributing to a trait; they do not tell us which genes; only molecular genetics can tell us this. Fortunately, we can now go beyond heritability estimates and straight to the DNA by genotyping individuals using simple cheek swabs for about $10 each. This eliminates the need for special twin or adoptee samples, but we do need cooperative studies with scientists having access to laboratories. Such studies are being conducted with increasing frequency, with the huge National Longitudinal Study of
Adolescent Health (ADD Health) study being one in which some very important genetic findings (the discovery of specific genes) relating to criminal behavior have been recorded (Beaver, 2006). It is emphasized that any individual gene only accounts for a miniscule proportion of the variance in criminal behavior, and that it contributes to a trait linked to criminality, not to criminality itself. Genes always have indirect effects on behavior via their effects on traits.

### Gene/Environment Interaction and Correlation

Gene/environment (G/E) interaction and G/E correlation describe people’s active transactions with their environment. **G/E interaction** involves the notion that people are differentially sensitive to identical environmental influences and will thus respond in different ways to them. For instance, a relatively fearless and impulsive child is more likely to seize opportunities to engage in antisocial behavior than is a fearful and constrained child. **G/E correlation** means that genotypes and the environments they find themselves in are related. These concepts enable us to conceptualize the indirect way that genes help to determine what aspects of the environment will and will not be important to us. There are three types of G/E correlation: passive, reactive, and active.

**Passive G/E correlation** is the positive association between genes and their environments that exists because biological parents provide children with genes for certain traits and an environment favorable for their expression. Children born to intellectually gifted parents, for instance, are likely to receive genes for above-average intelligence and an environment in which intellectual behavior is modeled and reinforced, thus setting them on a trajectory independent (passively) of their actions.

**Reactive G/E correlation** refers to the way others react to the individual on the basis of his or her evocative behavior. Children bring traits with them to situations that increase or decrease the probability of evoking certain kinds of responses from others. A pleasant and well-mannered child will evoke different reactions than will a bad-tempered and ill-mannered child. Some children may be so resistant to socialization that parents may resort to coercive parenting or simply give up, either of which may worsen any
antisocial tendencies and drive them to seek environments where their behavior is accepted. Reactive G/E correlation thus serves to magnify phenotypic differences by funneling individuals into like-minded peer groups (“birds of a feather flock together”).

Active G/E correlation refers to the active seeking of environments compatible with our genetic dispositions. Active G/E correlation becomes more pertinent as we mature and acquire the ability to take greater control of our lives because within the range of possibilities available in our cultures, our genes help to determine what features of the environment will and will not be attractive to us. Our minds and personalities are not simply products of external forces, and our choices are not just passive responses to social forces and situations. We are active “niche picking” agents who create our own environments just as they help to create us.

Genes imply human self-determination because, after all, our genes are our genes. As Colin Badcock (2000) put it: “Genes don’t deny human freedom; they positively guarantee it” (p. 71). Genes are constantly at our beck and call, extracting information from the environment and manufacturing the substances we need to navigate it. They are also what make us uniquely ourselves and thus resistant to environmental influences that grate against our natures. In short, genes do not constrain us, they enable us. This view of humanity is far more respectful of human dignity than the blank slate view that we are putty in the hands of the prevailing environmental winds.

Behavior Genetics and Criminal Behavior

A review of 72 behavior genetic studies conducted up to 1997 found that 93% were supportive of the hypothesis than genes affect antisocial behavior (Ellis & Walsh, 2000). Although there are no behavior genetic theories of criminal behavior per se, behavior genetic studies help us to temper and make more sense of traditional criminological theories. For instance, large behavior genetic studies conducted in the U. S. (Cleveland, Wiebe, van den Oord, & Rowe, 2000) and the U. K. (Moffitt & The E-Risk study team, 2002) showed that genetic factors play a large part in sorting individuals into different family structures (broken vs. intact homes), a variable often linked to antisocial behavior.

A major longitudinal study of child abuse and neglect that integrated genetic (the same MAO gene mentioned in the section vignette) data showed why only about one-half of abused/neglected children become violent adults (Caspi et al., 2002). This study showed that neither genetic risk nor abuse/neglect by themselves have much effect on antisocial behavior, but the odds of having a verified arrest history for a violent crime for subjects with both genetic and environmental risk factors (G/E interaction) were 9.8 times greater than the odds for subjects with neither.

Another study looked at Gottfredson and Hirschi’s (1990) assumption that parents are primarily responsible for their children’s self-control (Wright & Beaver, 2005). A modest relationship between parental practices and children’s self-control was found, but disappeared when genetic information was added. In other words, not using genetically informed methods leads researchers to misidentify important causal influences. Wright and Beaver (2005) concluded, “for self-control to be a valid theory of crime it must incorporate a more sophisticated understanding of the origins of self-control” (p. 1190).

Unlike the relatively strong genetic influences discovered for most human traits, genetic influences on antisocial behavior are modest, especially during the teenage years. A study of 3,226 twin pairs that found genes accounted for only 7% of the variance in antisocial behavior
among juvenile offenders, but 43% among adult offenders (Lyons et al., 1995). Heritability coefficients for most traits related to antisocial behavior are typically in the .20 to .80 range, and for antisocial behavior itself, two meta-analyses concluded that they are in the .40 to .58 range (Miles & Carey, 1997; Rhee & Waldman, 2002), with $h^2$ being higher in adult than in juvenile populations.

What this means is that the majority of delinquents have little, if any, genetic vulnerability to criminal behavior while a small minority may have considerable vulnerability. Pooling these two groups has the effect of elevating estimates of the overall influence of genes while minimizing it for those most seriously involved. For instance, although Mednick, Gabrielli, and Hutchings (1984) found a weak overall pattern of genetic effects for delinquency among a large number of young males, just 1.0% of the cohort (37 males) who had biological fathers with three or more criminal convictions accounted for fully 30% of all the cohort’s convictions. Genetic effects on antisocial behavior are most likely to be found among chronic offenders who begin offending prior to puberty and who continue to do so across the life course (Moffitt & Walsh, 2003).

The article by Anthony Walsh in this section further explains behavior genetic concepts and ties them to the anomie/strain theory. Walsh contends that achieving the American Dream, the success goal so central to anomie/strain theory, is a matter of having the requisite cognitive and temperamental characteristics to perform well in school and at work. He shows how behavior genetics can augment sociological criminology theories by illuminating the genetic underpinnings of many of their favored concepts such as SES, occupational mobility, frustration, and so forth.

**Evolutionary Psychology**

Evolutionary psychology explores human behavior using an evolutionary theoretical framework and seeks to explain human behavior with reference to human evolutionary history. Criminologists operating within the evolutionary framework explore how certain behaviors society now calls criminal may have been adaptive in ancestral environments. Evolutionary psychology complements behavior genetics because it informs us how the genes of interest came to be present in the first place. The primary difference between the two disciplines is that while behavior genetics looks for what makes people different, evolutionary psychology focuses on what makes us all the same. Another basic difference is that evolutionary psychology looks at ultimate level “why” questions (what evolutionary problem did this behavioral mechanism evolve to solve?), and behavioral geneticists look at proximate level “how” questions (to what extent is this behavioral mechanism influenced by genes in this population at this time?).

Evolutionary psychologists agree with most criminologists that although it is morally regrettable, crime is normal behavior for which we all have the potential (Kanazawa, 2003). Evolutionary logic tells us that if criminal behavior is normal, it must have conferred some evolutionary advantage on our distant ancestors. However, because modern environments are so radically different from the hunter/gatherer environments in which we evolved, many traits selected for their adaptive value at the time may not be adaptive today. It is important to realize that it is the traits underlying criminal behavior that are the alleged adaptations, not the specific acts; genes do not code themselves for burglarizing a house or stealing a car (Rowe, 1996).

Criminal behavior is a way to acquire resources illegitimately. Evolutionary psychologists refer to such behavior (whether it is defined as criminal or not) as cheating, and think
of individual traits associated with it, such as impulsiveness, aggression, and low empathy, in terms of normal distributions dispersed around adaptive species averages. Whether exploitation occurs depends on environmental triggers interacting with individual differences and with environmental constraints. Although we all have the potential to exploit and deceive others, we are a highly social and cooperative species with minds forged by evolution to form cooperative relationships built on trust (Barkow, 2006). Cooperation is typically contingent on the reciprocal cooperation of others, and is thus a tit-for-tat strategy favored by natural selection because of the benefits it confers. We cooperate with our fellows because we feel good when we do and because it identifies us as reliable and trustworthy, which confers valued social status on us.

Because cooperation occurs among groups of other cooperators, it creates niches for non-cooperators to exploit others by signaling their cooperation and then failing to follow through (Tibbetts, 2003). In the human species, criminal behavior may be viewed as an extreme form of defaulting on the rules of cooperation. But cheating comes at a cost, so before deciding to do so the individual must weigh the costs and benefits of cooperating versus defaulting. Cheating is rational (not to be confused with moral) when the benefits outweigh the costs. But if cheating is so rational, how did cooperation come to be predominant in social species? The answer is that cheating is only rational in circumstances of limited interaction and communication. Frequent interaction and communication breeds trust and bonding, and cheating becomes a less rational strategy because cooperators remember and retaliate against those who have cheated them. Ultimately, cooperation is the most rational strategy in any social species because each player reaps in the future what he or she has sown in the past.

Yet, we continue to see cheating behavior despite threats of exposure and retaliation. We do so because exposure and retaliation are threats only if cheats are constrained to operate within the same environment in which their reputations are known. Cheats can move from location to location meeting and cheating a series of others who are unaware of their reputation. This is the pattern of many career criminals who move from place to place, job to job, and relationship to relationship, leaving a trail of misery behind them before their reputation catches up. This is why cheats are more likely to prosper in large cities in modern societies than in small traditional communities where the threat of exposure and retaliation is great (Ellis & Walsh, 1997).

**The Evolution of Criminal Traits**

There are a number of evolutionary theories of crime, all of which focus on reproductive strategies. This is not surprising because from a biological point of view, the evolutionary imperative of all living things is reproductive success. There are two ways that members of any animal species can maximize reproductive success: parenting effort and mating effort. **Parenting effort** is the proportion of reproductive effort invested in rearing offspring, and **mating effort** is that proportion allotted to acquiring sexual partners. Because humans are born more dependent than any other animal, parenting effort is particularly important to our species. The most useful traits underlying parenting effort are altruism, empathy, nurturance, and intelligence (Rowe, 2002).

Humans invest more in parenting effort than any other species, but there is considerable variation within the species. Gender constitutes the largest division due to different levels of obligatory parental investment between the genders. Female parental investment necessarily
requires an enormous expenditure of time and energy, but the only obligatory investment of males is the time and energy spent copulating. Reproductive success for males increases in proportion to the number of females to whom they have sexual access, and thus males have evolved a propensity to seek multiple partners. Mating effort emphasizes quantity over quality (maximizing the number of offspring rather than nurturing a few), although maximizing offspring numbers is obviously not a conscious motive of any male seeking sex. The proximate motivation is sexual pleasure, with more offspring being a natural consequence (in pre-contraceptive days) when the strategy proved successful.

Reproductive success among our ancestral females rested primarily on their ability to secure mates to assist them in raising offspring in exchange for exclusive sexual access, and thus human females evolved a much more discriminating attitude about sexual behavior (Fisher, 1998; Geary, 2000). According to evolutionary biologists, the inherent conflict between the reckless and indiscriminate male mating strategy and the careful and discriminating female mating strategy drove the evolution of traits such as aggressiveness and the lowering of trait levels (relative to female levels) such as empathy and constraint that help males to overcome both male competitors and female reticence. The important point to remember is that although these traits were designed by natural selection to facilitate mating effort, they are also useful in gaining non-sexual resources via illegitimate means (Quinsey, 2002; Walsh, 2006).

The reverse is also true—traits that facilitate parenting effort underlie other forms of prosocial activity: “Crime can be identified with the behaviors that tend to promote mating effort and noncrime with those that tend to promote parenting effort” (Rowe, 1996, p. 270). Because female reproductive success hinges more on parenting effort than mating effort, females have evolved higher levels of the traits that facilitate it (e.g., empathy and altruism) and lower levels of traits unfavorable to it (e.g., aggressiveness) than males. Of course, both males and females engage in both mating and parenting strategies, and both genders follow a mixed mating strategy. It is only claimed that mating behavior is more typical of males and parenting effort is more typical of females.

Empirical research supports the notion that an excessive concentration on mating effort is linked to criminal behavior. A review of 51 studies relating number of sex partners to criminal behavior found 50 of them to be positive, and in another review of 31 studies it was found that age of onset of sexual behavior was negatively related to criminal behavior (the earlier the age of onset, the greater the criminal activity) in all 31 (Ellis & Walsh, 2000). A British cohort study found that the most antisocial 10% of males in the cohort fathered 27% of the children (Jaffee, Moffitt, Caspi, & Taylor, 2003), and anthropologists tell us that there are striking differences in behavior between members of cultures that emphasize either parenting or mating strategies. The world over, cultures emphasizing mating effort exhibit behaviors (low-level parental care, hypermasculinity, transient bonding) considered antisocial in Western societies (Ember & Ember, 1998). Finally, a recent molecular genetic study found the same genes that were significantly related to number of sexual partners were also significantly related to antisocial behavior (Beaver, Wright, & Walsh, in press).

The Neurosciences

Whatever the source of human behavior, it is necessarily funneled through the brain, arguably the most awe-inspiring structure in the universe. Although the brain is only about 2% of body mass, it consumes 20% of the body’s energy as it perceives, evaluates, and
responds to its environment (Shore, 1997). This three-pound marvel of evolutionary design is the CEO of all that we think, feel, and do. All our thoughts, feelings, emotions, and behavior are the results of communication networks of brain cells called neurons. The more “primitive” networks come “hard wired” at birth, but development of the higher brain areas depends a lot on environmental “software” downloaded after birth. The message neuroscience has for us is that the experiences we encounter largely determine the patterns of our neuronal connections, and thus our ability to successfully navigate our lives (Quartz & Sejnowski, 1997).

Neural networks are continually being made and selected for retention or elimination in a use-dependent process governed by the strength and frequency of experience, and it is biased in favor of networks that are most stimulated during early development (Restak, 2001). This is why bonding and attachment are so vital to human beings, and why abuse and neglect is so injurious. Chronic stress can produce neuron death via the production of stress hormones, and children with high levels of these hormones experience cognitive, motor, and social development delays (Gunnar, 1996). As Perry and Pollard (1998) point out: “Experience in adults alters the organized brain, but in infants and children it organizes the developing brain” (p. 36). Brains organized by stressful and traumatic events tend to relay events along the same neural pathways laid out by those early events because pathways laid down early in life are more resistant to elimination than pathways laid down later in life. A brain organized by negative events is ripe for antisocial behavior.

Reward Dominance and Prefrontal Dysfunction Theories

Reward dominance theory is a neurological theory based on the proposition that behavior is regulated by two opposing mechanisms, the behavioral activating system (BAS) and the behavioral inhibition system (BIS). The BAS is associated with the neurotransmitter dopamine and with pleasure areas in the brain (Gove & Wilmoth, 2003). The BIS is associated with serotonin and with brain structures that govern memory (Pinel, 2000). Neurotransmitters such as dopamine and serotonin are the chemical messengers that shunt information between neural networks. Dopamine facilitates goal-directed behavior and serotonin generally modulates behavior (Depue & Collins, 1999).
The BAS is sensitive to reward and can be likened to an accelerator motivating a person to seek rewarding stimuli. The BIS is sensitive to threats of punishment and can be likened to a brake that stops a person from going too far too fast. The BAS motivates us to seek whatever affords us pleasure, and the BIS tells us when we have had enough for our own good. A normal BAS combined with a faulty BIS, or vice versa, may lead to a very impulsive person with a “craving brain” that can lead him or her into all sorts of physical, social, moral, and legal difficulties, by becoming addicted to pleasures such as food, gambling, sex, alcohol, and drugs (Ruden, 1997).

While most of us are more or less equally sensitive to both reward and punishment (in state of dopamine/serotonin balance), in some people one system might dominate the other most of the time (Ruden, 1997). The theory asserts that criminals, especially chronic criminals, have a dominant BAS, which tends to make them overly sensitive to reward cues and relatively insensitive to punishment cues (Lykken, 1995). Reward dominance theory provides us with hard physical evidence relating to the concepts of sensation seeking, impulsiveness, and low self-control we have previously discussed because each of these traits is underlain by either a sticky accelerator (high dopamine) or faulty brakes (low serotonin).

A third system of behavior control is the flight/fight system (FFS) chemically controlled by epinephrine (adrenaline). The FFS is that part of the autonomic nervous system that mobilizes the body for vigorous action in response to threats by pumping out epinephrine. Fear and anxiety at the chemical level is epinephrine shouting its warning: “Attention, danger ahead; take action to avoid!” Having a weak FFS (low epinephrine) that whispers rather than shouts, combined with a BAS (high dopamine) that keeps shouting “Go get it” and a BIS (low serotonin) too feeble to object, is obviously very useful when pursuing all kinds of criminal and antisocial activities.

Another neurologically specific theory of criminal behavior is prefrontal dysfunction theory. The prefrontal cortex (PFC) is responsible for a number of human attributes such as making moral judgments, planning, analyzing, synthesizing, and modulating emotions. The PFC provides us with knowledge about how other people see and think about us, thus moving us to adjust our behavior to consider their needs, concerns, and expectations of us. These PFC functions are collectively referred to as executive functions and are clearly involved in prosocial behavior. If these functions are compromised in some way via damage to the PFC, the result is often antisocial behavior.

Positron emission tomography (PET) and functional magnetic resonance imaging (fMRI) studies consistently find links between PFC activity and impulsive criminal behavior. A PET study comparing impulsive murderers with murderers whose crimes were planned found that the former showed significantly lower PFC and higher limbic system activity (indicative of emotional arousal) than the latter and other control subjects (Raine, Meloy, Bihrl, Stoddard, LaCasse, & Buchsbaum, 1998). Cauffman, Steinberg, and Piquero (2005) combined reward dominance and PFC dysfunctions theories in a large-scale study of incarcerated and nonincarcerated youths in California and found that seriously delinquent offenders have slower resting heart rates and performed poorly relative to nondelinquents on various cognitive functions mediated by the PFC.

Jana Buñkin and Vickie Lettrel's review of 17 neuroimaging studies in this section show conclusively that impulsive violent behaviors are associated with PFC deficits. They interpret the findings in terms of problems with the PFC's regulation of negative emotionality. They also explore activity between the PFC and subcortical structures associated with violence and
aggression. Like many biosocial researchers, they make a plea for interdisciplinary studies of criminality so that the biological, psychological, and social factors associated with it can be better understood.

Lee Ellis’s evolutionary neuroandrogenic (ENA) theory presented in this section attempts to tie many genetic, evolutionary, and neurological factors together into a unified theory. Ellis claims that his theory can explain why many of the demographic correlates of crime, such as age, sex, and SES, as well as biological correlates, such as mesomorphic body build, heart rate, and brainwave patterns, exist. He begins with two assumptions that are ultimately about mating versus parenting effort: (1) Males have been naturally selected for engaging in status striving and resource procurement because over countless generations, females who have chosen mates based on a male’s ability to obtain resources will have left more offspring in subsequent generations than females who use other criteria for selecting mates. (2) Fetal exposure of male brains to testosterone makes them more prone to competitive status striving than females.

Table 8.1 summarizes the strengths and weaknesses of biosocial perspectives and theories.

**Evaluation of the Biosocial Perspective**

Biosocial theories have never been popular with mainstream social scientists because they were interpreted as implying a Lombrosian biological inferiority of criminals. This kind of thinking is rarer today as social scientists have become more sophisticated about the interaction of biology and environment (Robinson, 2004). There are still people who fear that “biological” theories can be used for racist ends, but as Bryan Vila (1994) remarks, “Findings can be used for racist or eugenic ends only if we allow perpetuation of the ignorance that underlies these arguments” (p. 329). Bigots and hate-mongers will climb aboard any vehicle that gives their prejudices a free ride, and they have done so for centuries before genes were heard of.

The strength of biosocial approaches lies in their ability to incorporate biological factors into their theories and to physically measure many of them via various chemical, electrophysiological, and neuroimaging methods. However, studies are more difficult to do and far more expensive than the typical social science study. If we want genetic information, we cannot simply go to the nearest high school and survey a few hundred students. Genetic studies require comparing samples consisting of pairs of identical and fraternal twins and/or adoptees, and these are difficult to come by. However, new technologies have allowed us to go straight to the DNA, thus eliminating the need for special samples consisting of paired subjects with known degrees of genetic relatedness.

It is difficult to make generalizations from the typical neuroimaging study because many consist of a small number of known offenders matched with a control group. Neuroimaging studies are extremely expensive to conduct (an average of $3,000 per scan), and many of them may only consist of 20 or 30 identified criminals matched with a control group of similar size. Nevertheless, biosocial studies provide criminologists with “harder” evidence than they are typically able to get, and this evidence will help them to more solidly ground their theories, and when numerous small studies tell the same story we are able to place more confidence in their conclusions.
Table 8.1  Summarizing Biosocial Perspectives and Theories

<table>
<thead>
<tr>
<th>Theory</th>
<th>Key Concepts</th>
<th>Strengths</th>
<th>Weaknesses</th>
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<tr>
<td>Behavior Genetics Perspective</td>
<td>Genes affect behavior in interaction with environmental influences. Heritability estimates the relative contribution of genetic and environmental factor traits affecting criminality. All individual traits are at least modestly influenced by genes.</td>
<td>Looks at both the genetic and environmental risk factors for criminal behavior. Understanding genetic contributions also identifies the complementary contributions of environmental factors.</td>
<td>Requires samples of twins and/or adoptees, which are difficult to come by. However, technology now enables us to eliminate the need for special samples and go straight to the DNA.</td>
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<td>Evolutionary Psychology Perspective</td>
<td>Human behavior is rooted in evolutionary history. Natural selection has favored victimizing tendencies in humans, especially males. These tendencies arose to facilitate mating effort, but are useful in pursuing criminal behavior as well. Criminals emphasize mating effort over parenting effort more than males in general.</td>
<td>Ties criminology to evolutionary biology. Mating effort helps to explain why males are more criminal than females and why criminals tend to be more sexually promiscuous than persons in general. Emphasizes that crime is biologically &quot;normal&quot; (although regrettable) rather than pathological.</td>
<td>Gives some the impression that because crime is considered “normal” it is justified or excused. Makes assumptions about human nature which may or may not be true. While recognizing that culture is important, it tends to ignore it.</td>
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<tr>
<td>Neuroscience Perspective</td>
<td>Whatever its origin, all stimuli are channeled through the brain before being given expression in behavior. The development of the brain is strongly influenced by early environmental experiences, especially those involving nurturance and attachment.</td>
<td>Shows how environmental experiences are physically “captured” by the brain. Emphasizes the importance of nurturing for optimal development of the brain. Uses sophisticated technology and provides &quot;harder&quot; evidence.</td>
<td>High cost of neuroimaging studies. Very small samples of known criminals are used, thus limiting generalizations. Linking specific brain areas to specific behaviors is problematic.</td>
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<td>Reward Dominance Theory</td>
<td>Behavioral activating (BAS) and behavioral inhibiting system (BIS) are dopamine and serotonin driven, respectively. Among criminals the BAS tends to be dominant over the BIS. This BIS/BAS imbalance can lead to addiction to many things, including crime.</td>
<td>Explains why low serotonin is related to offending (low serotonin = low self-control). Explains why criminality is persistent in some offenders because they develop a taste for the &quot;thrill of it all.&quot;</td>
<td>The neurological underpinnings of the BAS and BIS have been difficult to precisely identify. Studies difficult and expensive to conduct.</td>
</tr>
<tr>
<td>Prefrontal Dysfunction Theory</td>
<td>Frontal lobes control long-term planning and temper emotions and their expressions. Criminals have frontal lobes that fail to function as they do in most people, especially in terms of inhibiting actions that harm others.</td>
<td>Explains why moral reasoning is inversely related to involvement in persistent criminality. Explains why criminality has been linked to frontal lobe damage and to abnormal brain waves.</td>
<td>Dysfunction of the prefrontal lobes remains difficult to measure, even with fMRI scans. Some sampling difficulties noted for the neurosciences in general.</td>
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Policy and Prevention: 
Implications of Biosocial Theories

The policy issues suggested by the biosocial perspective are midway between the macro-level sociological suggestions aimed at whole societies or communities and the micro-level suggestions of psychological theories aimed at already convicted criminals. Mindful of how nurturing affects both gene expression and brain development in humans, many biosocial criminologists have advocated a wide array of “nurturant” strategies such as pre- and postnatal care for all women, monitoring infants and young children through the early developmental years, paid maternal leave, nutritional programs, and a whole host of other interventions (Vila, 1997; Walsh & Ellis, 1997).

Biosocial criminologists are typically in the forefront in advocating treatment over punishment, and toward this end, they have favored indeterminate sentences over fixed sentences (Lanier & Henry, 1998). Pharmacological treatments in conjunction with psychosocial treatments have proven to be superior to psychosocial treatment alone for syndromes (alcoholism, drug addiction, etc.) associated with criminal behavior (Walsh, 2002). Of course, there are always dangers of seeking simple medical solutions to complex social problems. Requiring sex offenders to take anti-androgen treatment to reduce the sex drive raises both medical and legal/ethical issues regardless of how effective the treatment is. Prescribing selective serotonin reuptake inhibitors such as Prozac and Zoloft helps to curb low self-control and irritability, but there is always the temptation to treat everyone the same regardless of their serotonin levels.

Some behavioral scientists tend to feel that identifying biological risk factors will lead to cessation of efforts to reduce crime through environmental improvement because such factors are wrongly thought to be intractable. But biosocial studies provide information about both environmental and biological risk factors and, as such, are “more likely to refine social policies by better specification of environmental factors than to divert funds from environmental crime prevention strategies” (Morley & Hall, 2003). In other words, they will enable us to better pinpoint environmental factors that may prove fruitful in our crime prevention efforts.

Summary

◆ Behavior geneticists study the genetic underpinning of traits and characteristics in populations by calculating heritability coefficients. There are no genes “for” any kind of complex human behavior; genes simply bias trait values in one direction or another. This view is respectful of human dignity because it implies self-determinism because our genes are our genes.

◆ Gene/environment interaction tells us that the impact an environmental situation (e.g., living in a crime ridden neighborhood) has on us depends on who we are, and gene/environment correlation tells us that who we are is a product of our unique genotype and the environments we find ourselves in.

◆ Genes have practically no influence on juvenile delinquency, probably because of the high base rate of delinquency. There are genetic effects for chronic and serious delinquents, but these few individuals tend to get “lost” in studies that combine them with those who limit their offending to adolescence. Adult criminality is much more influenced by genes. One of
the reasons that we find only modest genetic effects in criminality when the traits that underlie it are strongly influenced by genes is that parents have control over their children’s behavior, but little or none over the underlying traits.

◆ Evolutionary psychology focuses on why we have the traits we do and is more interested in their universality than in their variability. Crime is viewed as a normal but regrettable response to environmental conditions. By this it is meant that many human adaptations forged by natural selection in response to survival and reproductive pressures are easily co-opted to serve morally wrong purposes.

◆ In common with all sexually producing species, humans are preeminently concerned with their own survival and reproductive success. The traits designed to assist males in their mating efforts include many that can also assist them to secure other resources illegitimately; traits designed to assist females in their parenting efforts are conducive to prosocial behavior. Mating vs. parenting effort is not an either/or thing; males and females engage in both at various times in their lives, it is just that mating effort is more typical of males and parenting effort is more typical of females.

◆ Socially cooperating species create niches that cheats can exploit to their advantage by signaling cooperation but then defaulting. Cheating is a rational strategy in the short term, but invites retaliation in the long term. This is why chronic criminals rarely have successful relationships with others and why they typically die broke.

◆ Neuroscience tells us that genes have surrendered control of human behavior to the brain. Following genetic wiring to jump-start the process, the brain literally wires itself in response to environmental input. The softwiring of our brains is an electro-chemical process that depends on the frequency and intensity of early experiences. Adverse experiences can literally physically organize the brain so that we experience the world negatively, which is why nurturing, love, and attachment are so important to the healthy development of humans.

◆ Reward dominance theory informs us that the brain regulates our behavior through the BIS and BAS systems. The BIS and BAS systems (underlain by serotonin and dopamine neurotransmitters, respectively) in most people are balanced, but criminals tend to have either an overactive BAS or an underactive BIS. This means that their behavior is dominated by reward cues and relatively unaffected by punishment cues.

◆ Prefrontal dysfunction theory posits that the brain’s prefrontal cortex (PFC) is vital to the so-called executive functions such as planning and modulating emotions. If the PFC is damaged in any way, the individual is deficient in these executive functions and tends to be impulsive.

**EXERCISES AND DISCUSSION QUESTIONS**

1. If it could be shown with high scientific confidence that some young children inherit genes that put them at 85% risk for developing antisocial proclivities, what do you think should be done? Should their parents be warned to be especially vigilant and to seek early treatment for their children, or would such a warning tend to stigmatize children? What are the costs and benefits of each option?
2. We know that males, especially young males, are more likely to perpetrate and be victimized by violent crimes. Provide a plausible evolutionary explanation for this.

3. How might reward dominance theory add strength and coherence to low self-control theory?

**USEFUL WEB SITES**


**GLOSSARY**

Behavior genetics: A branch of genetics that studies the relative contributions of heredity and environment to behavioral and personality characteristics.

Behavioral activating system: A brain reward system associated chemically with the neurotransmitter dopamine.

Behavioral inhibition system: A brain system that inhibits or modulates behavior and is associated with serotonin.

Evolutionary psychology: A way of thinking about human behavior using a Darwinian evolutionary theoretical framework.

Flight/fight system: An autonomic nervous system mechanism that mobilizes the body for action in response to threats by pumping out epinephrine.

G/E correlation: The notion that genotypes and the environments they find themselves in are related because parents provide children with both.

G/E interaction: The interaction of genes and the environment.

Heritability: A concept defined by a number ranging between 0 and 1 indicating the extent to which variance in a phenotypic trait in a population is due to genetic factors.

Mating effort: The proportion of total reproductive effort allotted to acquiring sexual partners; traits facilitating mating effort are associated with antisocial behavior.

Neurons: Brain cells consisting of the cell body, an axon, and a number of dendrites.

Neurotransmitters: Brain chemicals that carry messages from neuron to neuron.

Parenting effort: The proportion of total reproductive effort invested in rearing offspring; traits facilitating parenting effort are associated with prosocial behavior.
Prefrontal cortex: Part of the brain that plays the major integrative and supervisory roles in the brain.

Prefrontal dysfunction theory: A neurological theory of antisocial behavior based on dysfunction of the prefrontal cortex.

Reward dominance theory: A neurological theory based on the proposition that behavior is regulated by two opposing mechanisms, the behavioral activating system (BAS) and the behavioral inhibition system (BIS).

READING

Behavior Genetics and Anomie/Strain Theory

Anthony Walsh

In this article, Anthony Walsh states that criminology is in need of a conceptual boost from the more fundamental sciences such as behavior genetics. He claims that behavior genetics is a biologically friendly environmental discipline because it tells us just as much about the effect of the environment on a trait as it does that of genes. He uses anomie/strain theory to illustrate this. Anomie/strain is about occupational success, or the lack thereof, and Walsh looks at the role of intelligence and temperament, both of which are highly heritable, on occupational success. He also shows how behavior genetics can throw light on many of criminology’s favored concepts.

The decade of the 1990s saw numerous reports of crisis within sociology in general as well as in criminology in particular. The substance of most of these reports is that the discipline is moribund and desperately needs something to breathe fresh life into it. The reason most often given for this state of affairs is sociology’s dogged refusal to entertain the possibility that biological factors may play an important role in helping us to understand phenomena of concern to us. Perhaps a major reason for this refusal can be found in what is probably the most cited passage in all of sociology. “The determining cause of a social fact should be sought among antecedent social facts and not among the states of the individual consciousness” (Durkheim, 1982:134). This dictum has become a sociological mantra used to assert and defend the ontological autonomy of the discipline. According to Udry (1995:1267), however, although Durkheim clearly meant this statement to be a boundary axiom defining sociology’s purview, sociologists came to think of it as “a true statement about the nature of the world instead of a set of deliberate blinders to help them focus their attention.”

There are signs that certain criminological theories are becoming more psychologically and biologically informed, and there have been a number of recent encapsulations of biosocial approaches in the criminology literature. Authors
of such overviews, however, tend not to be mainstream criminologists, but psychologists, psychiatrists, and biologists, and none of them has tried to show the relevance of biosocial variables to mainstream criminological theories. Perhaps biologically informed theories will continue to have minimal impact on mainstream criminology until it can be shown that they are not antithetical to current environmental theories of crime. My primary purpose in this paper is to demonstrate that at least one biologically informed discipline—behavior genetics—is not antithetical to at least one environmental theory—anomie/strain theory.

**Behavior Genetics**

I suggest that it is time for mainstream criminology to at least pull back its blinders and peek at what behavior genetics has to offer. Very few criminologists have taken biology beyond an introductory class, and even fewer believe that genetic factors are important in explaining criminal behavior, despite the overviews of biosocial theories that have been published in the past decade. The lack of human genetic knowledge is probably not as important as ideology in keeping our blinders on. To acknowledge that genes may play a role in criminality has been virtually taboo for decades, and many criminologists still suffer from “biophobia,” to use Ellis’s (1996a) expression.

Behavior genetics, a branch of quantitative genetics, is not so much a “biological” discipline as it is a biologically-friendly environmental discipline. Although the discipline’s main focus is to understand genetic influences on human behavior, traits, and abilities, behavior geneticists are aware that this cannot be accomplished without understanding the complementary role of the environment. Behavioral genetic studies have typically found that the environment accounts for more variance than does genetics in the most human traits, behaviors, and abilities. Thus, an often unappreciated aspect of behavior genetics is that it tells us as much, or sometimes more, about environmental effects as it does about genetic effects.

Behavior genetics research designs can also address and rectify a major problem with what has been called the standard social science model (SSSM) of socialization (Tooby and Cosmides, 1992). The problem is that the SSSM can never determine if any observed effects are primarily genetically or environmentally driven, i.e., whether parent/child or sibling/sibling similarities are caused primarily by shared genes or shared environments. This has led some socialization researchers to dismiss the entire SSSM of socialization as essentially useless.

We can only disentangle genetic from environmental effects if we can hold one constant. Behavior genetics does this using twin and adoption studies. The twin method compares pairs of individuals reared together (e.g., monozygotic twins) with a known degree of genetic relatedness with other pairs of reared-together individuals with a different degree of genetic relatedness (e.g., dizygotic twins), which holds environments constant and allows genes to vary. The adoption method examines genetically related individuals reared in different homes (or genetically unrelated individuals reared in the same home), which holds genes constant and allows environments to vary. In other words, the effects of shared environment can be determined by studying genetically unrelated individuals raised in the same environment, and the effects of heredity can be gauged by the phenotypical similarities of genetically related individuals reared apart.

Until molecular genetics identifies specific genes underlying specific traits, genetic effects must be inferred rather than directly demonstrated. Genetic effects are inferred by calculating a trait’s heritability ($h^2$). Heritability coefficients range between 0 and 1 and estimate the extent to which variance in a trait in a population is attributable to genes. Heritability is based on the assumption that if genes affect a trait, the more genetically related two individuals are, the more similar they will be on that trait. If genes do not affect a trait, it would be logically and empirically impossible to calculate a heritability coefficient for that trait significantly greater than zero.
Heritability estimates fluctuate among different populations and within the same population as they experience different environments. Knowing what percentage of variance in a trait is attributable to genetic factors does not set limits on creating other environments that may influence the trait. A large heritability coefficient informs us that the present environment at the present time has minimal effect (accounts for little variance) on the trait; it does not tell us what other environments may have appreciably greater effects on the trait. Heritability tells us what is affecting trait variance; it does not tell us what can affect it. Moreover, the heritability of a trait informs us only about how much of the variance in a trait is attributable to genes, not how much the trait is attributable to genetic influences.

A related misunderstanding about heritability is the assumption that it carves nature neatly at the joint because it apportions traits into “genetic” and “environmental” components (e.g., 60% genetic; therefore, 40% environmental). Although heritability estimates statistically transform genes and environments into components, they are not separable ingredients in the real world. Genes and environments have the same relationship to phenotypic attributes as hydrogen and oxygen have to water and length and width have to area. It takes twice as many hydrogen atoms as oxygen atoms to make a molecule of water and an area’s length may be twice its width, but in terms of the wholes they describe, the quantitative differences are meaningless. Without their complements, there would be no water or area, only a gas and a straight line. Likewise, genes and environments in isolation make no sense in terms of the phenotypic wholes they describe. There is no nature versus nurture, there is only nature via nurture.

In addition to apportioning variance into genetic and environmental components, the methods of behavior genetics yield a further benefit to social science in that they allow researchers to break down environmental variance into shared and nonshared components. Shared environments are environments of rearing that serve to make siblings alike (e.g., parental SES, religion, neighborhood, intactness of home), and non-shared environments are microenvironments unique to each sibling (birth order, differential treatment, different peers, etc.) that serve to make them different. A cascade of behavior genetic research has shown unequivocally that although shared rearing effects are real, albeit modest, during childhood and adolescence, they almost completely disappear in adulthood.

Agency and Gene/Environment Correlation

Social scientists are increasingly acknowledging that people’s choices are not passive responses to social and cultural situations, and that these choices are to some degree autonomous. Many social scientists have gravitated toward the concept of agency in response to the “oversocialized” conception of human nature that has for so long dominated the social sciences. Agency simply means that as individuals strive for autonomy, they affect their environments just as surely as they are affected by them.

Transformations of self and environment are achieved by the actions and interactions of human subjects propelled by the subjective meanings that different people assign to similar situations. This concept of agency, which has much to do with our wishes, goals, and desires, is highly congenial to behavior genetics, which has always emphasized that people make their environments. That is, people’s unique genotypes will largely determine what aspects of the social environment will be salient to them. This is a position considerably more respectful of human dignity (and more scientifically defensible) than is the image of human development that views it as little more than a process of class-, race-, age-, or gender-based adjustment to structural and cultural demands made on us. The concept of agency pulls us away from thinking of socialization as a mechanistic parent-to-child process and provides us with the skeleton of reciprocal effects thinking. Behavior genetics goes a step further to put the flesh on the bones of this thinking.
The concept of gene/environment (G/E) correlation is philosophically related to the concept of agency, but goes beyond it to provide an understanding of the underlying mechanisms that constitute the basis for the subjective meanings agency theorists articulate. G/E correlation essentially means that genotypes and the environments they encounter are not random with respect to one another, and that individuals are active shapers of their lives. The concept enables us to conceptualize the indirect way that genes exert their influence to help to determine the effective environment of the developing individual. Behavior geneticists differentiate between passive, reactive, and active G/E correlation.

Children raised by their biological parents experience passive G/E correlation by virtue of being provided with genes that underlie certain traits and a home environment favorable for their expression. A child born to highly intelligent parents, for example, typically receives genes conducive to high intelligence and a home in which intellectual activity is modeled and reinforced. The synergistic effects of correlated genes and environment will make for the unfolding of the child's intellectual abilities almost independently (passively) of what the child does. This means that the child has simply been exposed to the environment and has not been instrumental in forming it, not that the child does not actively engage it. On the downside, children born to low IQ, impulsive, or bad-tempered parents receive both genes and an environment developmentally biasing them in the same direction. The influence of passive G/E correlation declines dramatically from infancy to adolescence as the scope of environmental interaction widens and the person is confronted with and engages a wider variety of other people and behavioral options.

Reactive G/E correlation picks up the developmental trajectory as children grow older and are exposed to an increasing number of people and situations in their environments and begin to respond more actively to them. Children bring their developing phenotypical characteristics and abilities with them to the interpersonal situations they encounter that increase or decrease the probability of evoking certain kinds of responses from others. A bad-tempered child will evoke less solicitude than will a good-natured child, and a hyperactive, moody, and mischievous child will evoke less benign responses from others than will one who is pleasant and well behaved. Likewise, a child who shows enthusiasm and ability for school work evokes better treatment from teachers and will be afforded greater opportunities for advancement than will a child who shows little enthusiasm and ability for school work.

The important lesson of reactive G/E correlation is that the behavior of others toward the child is as much a function of the child's evocative behavior as it is of the interaction style of those who respond to it. Socialization is not something that others simply do to children; it is a reciprocal process that children and their caretakers engage in together. Some children may be difficult to control for even the most patient and loving parents. Some parents may abuse difficult children in their efforts to make them conform, and other parents may just give up trying to socialize their children. Both abusive and permissive responses to difficult children are likely to exacerbate their antisocial tendencies and drive them to seek others more accepting of their tendencies, presumably because the others toward whom they gravitate harbor such tendencies. Groups of individuals with similar tendencies provide positive reinforcement for each other and provide ample opportunities to exercise these tendencies. It is in this way that the feedback nature of reactive G/E correlation amplifies differences among phenotypes.

The seeking out of environments in which one feels accepted and psychologically comfortable is referred to as active G/E correlation. Large-scale twin studies provide striking evidence that genes play a very important role in “niche-picking.” A number of studies have reported that the similarity in intelligence, personalities, attitudes, interests, and constructed environments of monozygotic (MZ) twins is essentially unaffected by whether they were
reared together or apart. That is, MZ twins reared apart construct their environments and order their lives about as similarly as they would have had they been raised together, and this similarity is considerably greater than is the similarity between dizygotic (DZ) twins reared together.

Although such findings are robust, they appear counterintuitive to those who believe that the rearing environment mostly determines life outcomes. However, they make perfect sense to behavior geneticists, for whom it would be counterintuitive for people to either accept or to seek out environments incompatible with their genetic dispositions. Because MZ twins share 100% of their genes and DZ twins share, on average, only 50%, it makes sense that MZ twins would order their lives more similarly than would DZ twins. People with genes facilitative of different temperaments, traits, and abilities will seek out environments that mesh well with them (genes and environments will covary positively). It is no surprise to behavior geneticists that within the range of cultural possibilities and constraints, our genes set us on a developmental trajectory that will largely determine what features of the social world will be meaningful and rewarding to us, and what features will not.

Behavior Genetics and Antisocial Behavior

I must strongly emphasize that there is absolutely nothing in the concept of G/E correlation that can in any way be construed as supporting the notion of congenital criminality. Genes are self-replicating slices of DNA that code for proteins, which code for hormonal and enzymatic processes. There is no mysterious cryptography by which genes code for certain kinds of brains, which in turn code for different kinds of behaviors. Genes do not code for feelings or emotions either; what they do is make us differentially sensitive to environmental cues and modulate our responses to them. Genes always exert whatever influence they have on behavior in an environmental context. Although there can be no gene(s) “for” crime, there are genes that, via a number of neurohormonal routes, lead to the development of different traits and characteristics that may increase the probability of criminal behavior in some environments and in some situations.

A recent behavior genetic study illustrates the role of G/E correlation for antisocial behavior in late childhood/early adolescence (O’Connor et al., 1998). A number of adopted children were classified as either being or not being at genetic risk for antisocial behavior on the basis of their biological mothers’ self-reported antisocial behavior collected prior to the birth of their children. It was found that from ages 7 to 12, children at genetic risk for antisocial behavior consistently received more negative parenting from their adoptive parents than did children not at genetic risk. This effect was interpreted as reactive G/E correlation in that children’s poor behavior was seen as evoking negative parenting. O’Connor et al. (1998) did, however, find an environmentally mediated parental effect not attributable to reactive G/E correlation.

Another adoption study of antisocial behavior focused on G/E interaction (the differential effects of similar environments on different genotypes). Cadoret et al. (1995) examined the antisocial history of adopted children separated at birth from biological mothers with verified antisocial histories, compared with other adoptees with biological mothers with no known history of antisocial behavior. It was found that adverse adoptive home environments (divorce/separation, substance abuse, neglect/abuse, marital discord) led to significant increases in antisocial behavior for adoptees at genetic risk, but not for adoptees without genetic risk. Thus, both genes and environments operating in tandem (interacting) were required to produce significant antisocial behavior, whereas neither seemed powerful enough in this study to produce such effects independent of the other.

Antisocial behaviors, especially adolescent antisocial behaviors, are an interesting exception to the modest shared environmental
influences typically discovered for most human characteristics. Shared group influences reflect the socializing influences of peer groups, although such influences cannot be considered apart from the tendency of similar people to befriend one another. The shifting pattern of genetic and environmental effects is readily seen in studies of juvenile and adult offending.

Genetic factors do not have similar explanatory power across all environments and across all developmental periods. Few things point to the vital importance of the environment to gene expression than the fact that heritability coefficients are always higher in advantaged than in disadvantaged environments. Just as a rose will express its fullest genetic potential planted in an English garden and wither when planted in the Nevada desert, human beings will realize their genetic potential to the fullest when reared in positive environments and fall short of doing so when reared in negative environments. High heritabilities for positive traits index how well a society is doing in equalizing environmental opportunities.

Differential genetic effects also apply to delinquent and criminal behaviors. In environments where resistance to crime is low, very little variance in criminal behavior will be attributable to genes; in environments where resistance to crime is high, the genetic contribution will be high. Venables (1987), for example, found that (low) tonic heart rate was a significant predictor of antisocial behavior among high SES children, but not among low SES children. Similarly, Walsh (1992) found that cognitive imbalance (as measured by verbal/performance IQ discrepancy scores) significantly predicted violent delinquency in advantaged environments, but not in disadvantaged environments. This does not mean these studies found that low tonic heart rate or cognitive imbalance was more prevalent in advantaged environments. On the contrary, what it means is that environmental causes tend to overwhelm putative genetic causes in disadvantaged environments.

The environmental complexities illustrated by studies in this section make criminal/antisocial behavior especially appealing for behavior genetic analysis of environmental influence.

## Traits Linked to Middle-Class Success

In the following section, I briefly review the literature on the two major individual-level factors (temperament and intelligence) stressed by Agnew [in his general strain theory] (1992, 1997) as they relate to achieving middle-class success. Agnew remarks on a number of occasions that temperament and intelligence bear a strong relationship to problem-solving skills, and that the lower classes feel strain most acutely (1997:111–114). He never tries to make the connection between SES and these correlates of problem solving, although he is more than willing to state that such traits are a function of both biological and social factors. After the discussion of temperament and intelligence, I will attempt to show how other biosocial variables can be usefully integrated with Agnew’s (1997) recently formulated developmental version of GST.

### Temperament

Temperament refers to an individual’s habitual mode of emotionally responding to stimuli. Temperamental style is identifiable very early in life, and it tends to be stable across the life course. Variance in temperamental measures is largely a function of heritable variation in central and autonomic nervous system arousal. Heritability coefficients for the various components of temperament range from about .40 to .80. Temperamental differences are largely responsible for making children differentially responsive to socialization. The unresponsiveness of a bad tempered (sour, unresponsive, quick to anger) child is exacerbated by the fact that temperaments of children and their parents are typically positively correlated. Parents of children with
difficult temperaments tend to be inconsistent disciplinarians, irritable, impatient, and unstable, which makes them unable or unwilling to cope constructively with their children. Their children are thus burdened with both a genetic and an environmental liability. A cascade of evidence shows that children with difficult temperaments evoke negative responses from parents, teachers, and peers, and that these children find acceptance only in association with peers with similar dispositions (Moffitt, 1996).

Various physiological measures confirm that disinhibited temperament is associated with central nervous system (CNS) and peripheral nervous system (PNS) underarousal (suboptimal levels of arousal under normal environmental conditions). Individuals differ in the level of environmental stimulation they find optimal because of variation in the CNS's reticular activating system (a finger-size cluster of cells extending from the spinal cord that monitors incoming stimuli for processing by the cerebral cortex), and the PNS's autonomic nervous system. What is optimal for most of us will be stressful for some and boring for others. Suboptimally aroused people are easily bored and continually seek to boost stimuli to more comfortable levels. This search for amplified pleasure and excitement often leads the underaroused person into conflict with the law. A number of studies have shown that relative to the general population, criminals, especially those with the most serious criminal records, are chronically underaroused as determined by EEG brain wave patterns, resting heart rate and skin conductance, and histories of hyperactivity and attention deficit disorders. Individuals who are chronically bored and continually seeking intense stimulation are not likely to apply themselves to school or endear themselves to employers. One study found that various measures of reticular and autonomic nervous system arousal taken at age 15 correctly classified 74.7% of subjects as “criminal” or “noncriminal” at age 24 after controlling for a number of social factors (Raine et al., 1990).

Temperament provides the foundations for personality, which emerges from its interaction with the environment. Conscientiousness, one of the “big five” factors of personality, is a trait that is particularly important to success in the work force and is thus important to anomie/strain theory. Conscientiousness is a continuous trait ranging from well organized, disciplined, reliable, responsible, and scrupulous at one end of the continuum, to disorganized, careless, unreliable, irresponsible, and unscrupulous at the other. As we might expect, variance in conscientiousness is heritable. An analysis of 21 behavior genetic studies of conscientiousness found a median heritability of .66. In short, individuals with temperaments biasing them in the direction of being lacking in conscientiousness typically do not possess the personal qualities needed to apply themselves to the often long and arduous task of achieving legitimate occupational success. They will become “innovators” or “retreatists,” not because a reified social structure has denied them access to the race, but because they find the race intolerably boring and busy themselves with more “exciting” pursuits instead.

**Intelligence**

Intelligence, as operationalized by IQ tests, is another obvious determinant of both occupational success and coping strategy, but also one that is conspicuously absent in sociological discussions of social status. As Lee Ellis has opined: “Someday historians of social science will be astounded to find the word intelligence is usually not even mentioned in late-twentieth-century text books on social stratification” (1996b:28).

Few scientists who study intelligence seriously doubt the importance of genes as well as the environment to explaining IQ variation. Twin studies, adoption studies, position electron tomography and magnetic resonance image scan studies, and even molecular genetic studies all point to substantial genetic effects on intelligence. Contrary to the claims of many
social scientists, the National Academy of Sciences and the American Psychological Association’s Task Force on Intelligence have concluded that there is no empirical evidence to indicate that IQ tests are biased against any racial/ethnic group or social class.

The litmus test for any assessment tool is its criterion-related validity—its ability to predict outcomes. An examination of 11 meta-analyses of the relationship between IQ and occupational success found that IQ predicted success better than did any other variable in most occupations, particularly in higher status occupations, and that it predicted equally well for all races/ethnic groups. Intelligence is particularly important in open and technologically advanced societies. Although there is no such thing as a totally open society, unlike the rigid caste-like societies of the past. In the rigid and aristocratic caste societies of the past, genes played almost no role in determining social class. They play an increasingly important role in more modern and egalitarian societies, however. Genes, and the individual differences they underlie, become important in determining SES in roughly direct proportion to equalization of environments. Although this may seem paradoxical at first blush, it is a basic principle of genetics: The more homogeneous (or equal) the environment, the greater the heritability of a trait; the more heterogeneous (unequal) the environment, the lower the heritability of a trait. High heritability coefficients for socially important traits tell us that the society is doing a good job of equalizing the environment.

The degree of occupational mobility in the U.S. labor force can be gauged by a major study’s finding that 48% of sons of upper white-collar status fathers had lower status occupations than did their fathers, with 17% falling all the way to “lower manual” status, and that 51% of sons of lower manual status fathers achieved higher status, with 22.5% achieving “upper white-collar” status (Hurst, 1995: 270). Given this degree of upward/downward social mobility, and given the degree to which IQ predicts it equally for all races and social classes, it is difficult to maintain that any group is systematically denied access to legitimate opportunities to attain middle-class status.

Social scientists are more prone to attribute IQ level to SES level rather than the other way around. A large number of studies have found the correlation between parental SES and children’s IQ to be within the .30 to .40 range (which is predictable from polygenic transmission models). However, the correlation between individuals’ IQ and their attained adult SES is in the .50 to .70 range. As Jensen remarks: “If SES were the cause of IQ [rather than the other way around], the correlations between adults’ IQ and their attained SES would not be markedly higher than the correlation between children’s IQ and their parents’ SES” (1998: 491).

If differential IQ predicts differential adult SES, and if the lack of success leads to a mode of adaptation that includes criminal activity, IQ must be a predictor of criminal behavior. When evaluating the relatively small (eight IQ points) difference said to separate criminals and noncriminals, we must remember that researchers do not typically separate what Moffitt (1993) calls adolescent-limited (AL) and “life-course-persistent” (LCP) offenders. As statistically normal individuals responding to the contingencies of their environments, we would not expect AL offenders to be significantly different from nonoffenders on IQ, and they are not. Moffitt (1996) reports a one-point mean IQ deficit between AL offenders and nonoffenders, but a 17-point deficit between LCP offenders and nonoffenders, and Stattin and Klackenberg-Larsson (1993) found a mean deficit of 4 points between nonoffenders and “sporadic” offenders and a 10-point difference between nonoffenders and “frequent” offenders. Aggregating temporary and persistent offenders creates the erroneous perception that IQ has minimal impact on antisocial behavior.

Although these studies separated temporary and persistent offenders, they did not separate IQ subtest scores. This also leads to an
underestimation of the effects of IQ by pooling verbal IQ (VIQ), which uniformly shows a significant difference between offenders and nonoffenders, and performance IQ (PIQ), which typically does not. The most serious and persistent criminal offenders tend to have a PIQ score exceeding their VIQ score by about 12 points. Low verbal IQ (about one standard deviation below the mean) indexes poor abstract reasoning, poor judgment, poor school performance, impulsiveness, low empathy, and present orientedness. None of these traits is conducive to occupational success, but it is conducive to antisocial behavior, especially if combined with a disinhibited temperament.

**Agnew’s Developmental GST and Other Biosocial Processes**

Agnew’s (1997) developmental strain theory attempts to explain why antisocial behavior peaks during adolescence, focusing on increases in negative relationships with others during this period and the tendency to cope with the resulting strain through delinquency. Thus, a number of situations experienced as aversive are hypothesized to account for the age effect on crime and delinquency. As other theorists have pointed out, however, the age effect tends to remain robust, controlling for a number of demographic and situational variables, indicating that none of the various social correlates of age predict crime as well as age. For instance, Udry’s (1990) sociological model found that age remained the strongest predictor of “problem behavior,” controlling for a number of other independent variables. However, in his biosocial model that included measures of testosterone (T) and sex hormone binding globulin (SHBG), age dropped out of the equation, prompting him to suggest that age is a proxy for the hormonal changes of puberty.

During puberty, male T-levels increase 10- to 20-fold and SHBG is halved. Although the heritability of base-level T is around .60, the environmental effects on this hormone are well known. It is plain that T/SHBG ratios alone cannot explain the dramatic increase in antisocial behavior during this period, nor can they explain the fairly rapid decline in such behavior in the late teens and early twenties, because the decline does not correspond with a similar decline in T. Whatever the environmental or hormonal correlates of the increase and decline in adolescent antisocial behavior are, they are necessarily mediated by the brain.

Recent MRI studies of brain development confirm that the prefrontal cortex (PFC) is the last part of the human brain to fully mature. The PFC is the part of the brain that serves various executive functions, such as modulating emotions from the more primitive limbic system and making reasoned judgments. The PFC undergoes an intense prepubescent period of synaptogenesis and a period of pruning of excess synapses during adolescence. This process of synaptic elimination may be part of the reason many young persons find it difficult to accurately gauge the meanings and intentions of others and to experience more stimuli as aversive.

In addition to the synaptic pruning process, the adolescent’s PFC is less completely myelinated than is the adult PFC. Myelination is important to the speed and conductive efficiency of neurotransmission. The fact that many syndromes associated with delinquency, such as oppositional disorder and conduct disorder/socialized type, first appear during this period may reflect a brain that is sometimes developmentally not up to the task of dealing rationally with the strains of adolescence. For instance, magnetic resonance imaging studies have shown that only the emotional limbic system is activated for many adolescents when shown photographs of frightened people, whereas both the limbic system and the PFC show activity among mature adults. This is another indication that the PFC is probably not performing its reasoning and emotion-modulating duties efficiently for at least some adolescents.
The increase in behavior-activating hormones coupled with an immature brain reflect two biological processes temporarily on conflicting trajectories that may both generate and exacerbate the strains of adolescence. This conjecture is supported by studies indicating that boys entering puberty early throw significantly more temper tantrums than do later maturing boys, and that early-maturing girls engage in significantly more problem behaviors than do later-maturing girls. Also consistent with this is the finding that T-levels predict future problem behavior only for early-pubertal-onset boys, again implying that the immature adolescent brain may facilitate a tendency to assign faulty attributions superimposed on an unfamiliar and diffuse state of physiological arousal.

Many other neurohormonal processes have the potential to assist anomie/strain theorists to understand strain across the life span, particularly during the teenage years. These include the shifting ratios of behavior-facilitating dopamine and the behavior-moderating serotonin during adolescence. The deaminating enzyme monoamine oxidase, which removes excess neurotransmitters at the synapse, is at its lowest during this period. These neurochemical fluctuations suggest that adolescence may be a period in which the brain is particularly sensitive to rewards and relatively insensitive to punishment, a combination facilitative of risk-taking and sensation-seeking behaviors.

It has long been known that humans and other animals in a low serotonin state are prone to violence, impulsiveness, and risk taking, especially if combined with high T. However, none of this means that teenagers are at the mercy of their biology, or that the environment has little impact. Serotonin levels, like T-levels, largely reflect environmental influences, and the lower average levels of serotonin during adolescence are as likely to be the effect of the increased strains of this period as they are to be the cause (Bernhardt, 1997). The stresses of adolescence outlined in Agnew’s (1997) theory prompt the release of corticosteroids, which in turn suppress serotonin receptors. Thus, the vicissitudes of biology and social situations during this period of life combine in synergistic fashion to become both the producers and the products of strain. Further exploration of these interesting processes is beyond the scope of this paper.

**Conclusion**

I have attempted to show how behavior genetics can complement, extend, and add coherence to criminological theory, using one of its most revered and long-lived theories as an illustration. Perhaps all social scientists would acknowledge in the abstract that human behavior is the result of complex interactions between genes and environments, but having done so, most will continue to neglect the genetic 50% of the human behavioral equation in their thinking and research. As I have repeatedly emphasized, behavior genetics is not a “biological” perspective of human behavior. It is a biosocial perspective that takes seriously the proposition that all human traits, abilities, and behaviors are the result of the interplay of genetics and environments, and it is the only perspective with the research tools to untangle their effects. Given the exponential increase in knowledge in genetics over the past decades, criminologists cannot continue to reject insights from behavior genetics if the discipline is to remain scientifically viable. The history of science tells us that cross-disciplinary fertilization by a more mature science has, without exception, proven to be of immense value to the immature science. Criminology will be no exception.
Reference


**Discussion Questions**

1. How does the concept of G/E correlation highlight the role of human agency in development?

2. Why is talking about the role of intelligence in occupational success (and crime) controversial?

3. Outline the ways in which behavior genetics has thrown light on the anomie/strain tradition.
Neuroimaging Studies of Aggressive and Violent Behavior

Current Findings and Implications for Criminology and Criminal Justice

Jana L. Bufkin and Vickie R. Luttrell

This article reviews neuroimaging studies with the goal of showing how neuroscience can advance criminological theories and inform criminal justice practice. The availability of new functional and structural neuroimaging techniques has allowed researchers to localize brain areas that may be dysfunctional in offenders who are aggressive and violent. Bufkin and Luttrell’s review of 17 neuroimaging studies reveals that the areas associated with aggressive and/or violent behavioral histories, particularly impulsive acts, are located in the prefrontal cortex and the medial temporal regions. These findings are explained in the context of negative emotion regulation, thus supporting many studies outside of neuroscience that link criminality to low self-control and negative emotionality. Bufkin and Luttrell provide suggestions concerning how such findings may affect future theoretical criminology, crime prevention efforts, and treatment in criminal justice.

Aggressive and/or violent behaviors persist as significant social problems. In response, a substantial amount of research has been conducted to determine the roots of such behavior. Case studies of patients with neurological disorders or those who have suffered traumatic brain injury provide provocative insights into which brain regions, when damaged, might predispose to irresponsible, violent behavior. Psychophysiological and neuropsychological assessments have also demonstrated that violent offenders have lower brain functioning than controls, including lower verbal ability and diminished executive functioning. However, until recently it has been impossible to determine which brain areas in particular may be dysfunctional in violent individuals. With the availability of new functional and structural neuroimaging techniques, such as single-photon emission computed tomography (SPECT), positron emission tomography (PET), magnetic resonance imaging (MRI) and functional MRI (fMRI), it is now possible to examine regional brain dysfunction with a higher sensitivity and accuracy than was possible with previous techniques. This newfound ability to view the brain “in action” has broadened our understanding of the neural circuitry that underlies emotional regulation and affiliated behaviors. In particular, evidence suggests that individuals who are vulnerable to faulty regulation of negative emotion may be at increased risk for aggressive and/or violent behavior.

In this review, we evaluate the proposed link between faulty emotion regulation and aggressive or violent behavior. We define *aggression* as any threatening or physically assaultive behavior directed at persons or the environment. *Violence* refers to behaviors that inflict physical harm in violation of social norms. Specifically, we (a) discuss briefly the neurobiology of emotion regulation and how disruptions in the neural circuitry underlying emotion regulation might predispose to impulsive aggression and violence; (b) summarize the results of modern neuroimaging studies that have directly assessed brain functioning and/or structure in aggressive, violent, and/or antisocial samples and evaluate the consistency of these findings in the context of negative emotion regulation; and (c) discuss theoretical and practical implications for criminology and criminal justice.

**Emotion Regulation and Theoretical Links to Impulsive Aggression and Violence**

Emotion is regulated by a complex neural circuit that involves several cortical areas, including the prefrontal cortex, the anterior cingulate cortex (ACC), the posterior right hemisphere, the insular cortex, as well as several subcortical structures, such as the amygdala, hippocampus, and thalamus. These cortical and subcortical areas are intricately and extensively interconnected. In this article, we focus on three key elements of this neural circuitry: the prefrontal cortex, the ACC, and the amygdala.

The prefrontal cortex is a histologically heterogeneous region of the brain and has several (somewhat) functionally distinct sectors, including the ventromedial cortex and the orbitofrontal cortex (OFC). Damage to the ventromedial cortex and its behavioral affiliations have been assessed in case studies of individuals who experienced traumatic brain injury, either during childhood or adulthood, and in large, systematic studies on cohorts of war veterans with head injury.

Studies have found that patients with early-onset ventromedial lesions experience an insensitivity to future consequences, an inability to modify so-called risky behaviors even when more advantageous options are presented, and defective autonomic responses to punishment contingencies. Studies have also demonstrated that patients with adult-onset ventromedial damage show defects in real-life decision making, are oblivious to the future consequences of their actions, seem to be guided by immediate prospects only, and fail to respond autonically to anticipated negative future outcomes.

The OFC, also a part of the prefrontal circuit, receives highly processed sensory information concerning a person's environmental experiences. The OFC is hypothesized to play a role in mediating behavior based on social context and appears to play a role in the perception of social signals, in particular, facial expressions of anger. Blair et al. (1999), using PET scans, assessed 13 male volunteers as they viewed static images of human faces expressing varying degrees of anger. They found that increasing the intensity of angry facial expressions was associated with enhanced activity in participants' OFC and the ACC. Dougherty et al. (1999) used functional neuroimaging and symptom provocation techniques to study the neurobiology of induced anger states and found that imaginal anger was associated with enhanced activation of the left OFC, right ACC (affective division), and bilateral anterior temporal regions. Also using imaginal scenarios, Pietrini et al. (2000) found that functional deactivation of OFC areas was strongest when participants were instructed to express unrestrained aggression toward assailants rather than when they tried to inhibit this imaginal aggression. Taken together, these lines of evidence support the suggestion that heightened activity in the left OFC may prevent a behavioral response to induced anger.

Based on these findings, and consistent with fearlessness theories of human aggression, a logical prediction is that OFC and ACC activity in response to provocation may be attenuated in
certain individuals, predisposing them to aggression and violence. Consistent with this prediction, patients with OFC damage tend to exhibit poor impulse control, aggressive outbursts, verbal lewdness, and a lack of interpersonal sensitivity, which may increase the probability of sporadic so-called crimes of passion and encounters with the legal system. In contrast, evidence suggests that the ACC plays a role in processing the affective aspects of painful stimuli, such as the perceived unpleasantness that accompanies actual or potential tissue damage.

In addition to the prefrontal cortex and the ACC, another hypothesized neural component of emotion regulation is the amygdala, a subcortical structure, which is located on the medial margin of the temporal lobes. Similar to the OFC, the amygdala appears to play a role in extracting emotional content from environmental stimuli and may also play a role in individuals’ ability to regulate negative emotion. However, neuroimaging studies have found that the amygdala is activated in response to cues that connote threat, such as facial expressions of fear (instead of anger), and that increasing the intensity of fearful facial expressions is associated with an increased activation of the left amygdala.

Davidson, Putnam, et al. (2000) suggested that individuals can typically regulate their negative affect and can also profit from restraint-producing cues in their environment, such as others’ facial expressions of fear or anger. Information about behaviors that connote threat (e.g., hostile stares, threatening words, or lunging postures) is conveyed to the amygdala, which then projects to other limbic structures, and it is there that information about social context derived from OFC projections is integrated with one’s current perceptions. The OFC, through its connections with other prefrontal sectors and with the amygdala, plays an important role in inhibiting impulsive outbursts because prefrontal activations that occur during anger arousal constrain the impulsive expression of emotional behavior.

Davidson, Putnam, et al. (2000) also proposed that dysfunctions in one or more of these regions and/or in the interconnections among them may be associated with faulty regulation of negative emotion and an increased propensity for impulsive aggression and violence. First, people with prefrontal and/or amygdalar dysfunction might misinterpret environmental cues, such as the facial expressions of others, and react impulsively, as a preemptive strike, to a misperceived threat. The perception of whether a stimulus is threatening is decisive in the cognitive processing leading to the aggressive behavior. Evidence suggests that individuals vary considerably in their ability to suppress negative emotion. Therefore, individuals with decreased prefrontal activity may have greater difficulty suppressing negative emotions than those individuals who have greater prefrontal activation. Finally, although prefrontal activity helps one to suppress negative emotion, this negative emotion is generated by subcortical structures, including the amygdala. Therefore, an individual may be more prone to violence in general, and impulsive violence, in particular, if prefrontal functioning is diminished in relation to subcortical activity.

Research on individuals who have suffered traumatic head injury is of key importance in understanding the neural substrates of aggressive and/or violent behavior; however, Brower and Price (2001) noted many limitations of head injury studies, such as inadequate controls for known risk factors, including prior history of aggressive or violent behavior, socioeconomic status, stability of employment, and substance abuse. Research of behavior following head injury is also one step removed from the question of whether aggressive and/or violent individuals (who may have no history of head trauma) have neurological dysfunction localized to specific areas in the brain.

Studies of aggressive, violent, and/or antisocial offenders using functional (SPECT and PET) and structural (MRI) neuroimaging are beginning to reveal abnormalities in these groups (Raine, Lencz, et al., 2000). Specifically, 17 neuroimaging studies have been conducted on samples derived from forensic settings, prisons,
Section 8  Neuroimaging Studies of Aggressive and Violent Behavior

psychiatric hospitals, and on violent offenders who are noninstitutionalized. Our review of these works reveals four consistent patterns: 
(a) prefrontal dysfunction is associated with aggressive and/or violent behavioral histories; 
(b) temporal lobe dysfunction, particularly left-sided medial-temporal (subcortical) activity, is associated with aggression and/or violence; 
(c) the relative balance of activity between the prefrontal cortex and the subcortical structures is associated with impulsive aggression and/or violence; and (d) the neural circuitry underlying the regulation of emotion and its affiliated behaviors is complex. Each of these patterns is described in theoretical context below.

Prefrontal Dysfunction Is Associated With Aggressive and/or Violent Behavioral Histories

Of the 17 studies reviewed, 14 specifically examined possible links between frontal lobe pathology and aggressive and/or violent behavior. In the 10 SPECT and PET studies, 100% reported deficits in either prefrontal (8 of 10 studies) or frontal (2 of 10 studies) functioning in aggressive, violent, and/or antisocial groups compared to nonaggressive patients or healthy controls. Analyses of specific regions in the medial prefrontal cortex revealed that individuals who were aggressive and/or violent had significantly lower prefrontal activity in the OFC (4 of 10 studies), anterior medial cortex (5 of 10 studies), medial frontal cortex (2 of 10 studies) and/or superior frontal cortex (1 of 10 studies). In the four MRI studies, 50% (2 of 4 studies) reported decreased grey matter volume in prefrontal or frontal regions, and 25% (1 of 4 studies) reported nonspecific white matter abnormalities, not localized to the frontal cortex.

The consistency with which prefrontal disruption occurs across studies, each of which investigated participants with different types of violent behaviors, suggests that prefrontal dysfunction may underlie a predisposition to violence. Evidence is strongest for an association between prefrontal dysfunction and an impulsive subtype of aggressive behavior. Empirical findings concerning the regulation of negative emotion suggest that prefrontal sectors, such as the OFC, appear to play a role in the interpretation of environmental stimuli and the potential for danger. Consequently, disruptions in prefrontal functioning may lead individuals who are impulsive and aggressive to misinterpret situations as threatening and potentially dangerous, which in turn increases the probability of violent behavior against a perceived threat.

Nevertheless, four caveats are noteworthy. First, although prefrontal disruption was consistently related to aggressive and/or violent behavior, this association may reflect a predisposition only, requiring other environmental, psychological, and social factors to enhance or diminish this biological risk. Second, prefrontal dysfunction has also been documented in a wide variety of psychiatric and neurological disorders not associated with violence, and it may be argued that frontal hypometabolism is a general, nonspecific finding associated with a broad range of conditions. However, Drevets and Raichle (1995) reported that although frontal deficits have been observed in conditions, such as major depression, schizophrenia, and obsessive-compulsive disorder, the neurological profile for individuals who are aggressive and/or violent is different from these other groups. For example, while murderers exhibit widespread bilateral prefrontal dysfunction, individuals with depression tend to have disruptions localized in the left hemisphere only and to the left dorsolateral prefrontal cortex, in particular. (See Raine, Buchsbaum, et al., 1997, for a discussion of alterations in brain functioning across a variety of psychiatric conditions.)

Of the 10 SPECT and PET studies reviewed, 70% reported temporal lobe dysfunction in aggressive and/or violent groups, with reductions in left temporal lobe activity in 6 of 7 studies. Examination of the medial-temporal lobe, which includes subcortical structures, such as the amygdala, hippocampus, and basal ganglia, revealed that subcortical disruptions also characterized
individuals who were aggressive and/or violent (4 of 7 studies). In the six MRI studies that examined the possibility of temporal lobe abnormalities, 100% (6 of 6 studies) reported temporal irregularities, including asymmetrical gyral patterns in the temporal-parietal region, decreases in anterior-inferior temporal lobe volume (including the amygdala-hippocampal region or adjacent areas), increases in left temporal lobe volume, or pathologies specific to the amygdala.

It is important to note that excessive right subcortical activity or abnormal temporal lobe structure was most common in patients with a history of intense violent behavior, such as that seen in those with intermittent explosive disorder rather than in patients who had aggressive personality types or who had high scores on an aggression scale. In humans, right-hemisphere activation has been suggested to play a role in the generation of negative affect. Therefore, increased subcortical activity in the right hemisphere could lead an individual to experience negative affect that promotes aggressive feelings and acts as a general predisposition to aggression and violence. These findings are generally consistent with current conceptions of emotion regulation and its purported relationship to impulsive violence, in particular.

The Relative Balance of Activity Between the Prefrontal Cortex and the Subcortical Structures Is Associated With Impulsive Aggression and/or Violence

Previous research has suggested that individuals may be predisposed to impulsive violence if prefrontal functioning is diminished relative to subcortical activity. Raine, Meloy, et al. (1998) found that reduced prefrontal functioning relative to subcortical functioning was characteristic of those who commit impulsive acts of aggression and/or violence. By contrast, aggression and/or violence of a predatory nature was not related to reduced prefrontal and/or subcortical ratios. They also suggest that although most biological studies of aggression and/or violence have not distinguished between impulsive and premeditated aggression, this distinction is likely relevant to understanding the neuroanatomical and functional underpinnings of these behaviors.

An additional line of evidence that lends support to the impulsive and/or predatory distinction comes from investigations regarding the mechanism underlying the suppression of negative emotion. The neurochemical link mediating prefrontal and/or subcortical interactions is purportedly an inhibitory serotonergic connection from the prefrontal cortex to the amygdala. The prefrontal cortex is a region with a high density of serotonin receptors, which sends efferents to the brainstem where most of the brain’s serotonin-producing neurons originate. The prefrontal cortex, amygdala, and hippocampus also receive serotonergic innervation. Therefore, it is logical that dysfunction in the prefrontal and/or subcortical regions disrupts serotonergic activity in the brain. Consistent with this hypothesis, the serotonergic system has been shown to be dysfunctional in victims of violent suicide attempts, impulsive violent offenders, impulsive arsonists, violent offender and arson recidivists, children and adolescents with disruptive behavior disorders, and “acting out” hostility in normal volunteers. In all those studies, low serotonin levels were strongly related to the maladaptive behaviors noted.

Implications for Criminology and Criminal Justice

Historically, paradigms guiding criminological programs of study have tended to bypass complex webs of interconnections that produce and reproduce criminality, favoring instead an emphasis on one dimension or level of analysis. The trend has been to maintain a specialized focus, often within the confines of a sociological or a legalistic model. Attempts to expand the image of crime through theory integration, which have surfaced quite frequently since the mid-1970s, shift attention to different realities of crime. The general emphasis, however, has been
on the integration of ideas within and/or across the two dominant paradigms rather than on a broader, interdisciplinary strategy.

Resistance to interdisciplinarity or disciplinary cross-fertilization has not been inconsequential. Failure to incorporate interdisciplinary insights has stifled exploration of the intersections among structure, culture, and the body, leaving a knowledge void where provocative social facts “merely hang in space as interesting curiosities” (Pallone & Hennessey, 2000, chap. 22, p. 11), and critical questions go unanswered. More specifically, lack of an imagination of how nurture and nature interact to affect behavior, or what may be understood as biography in historical context, has resulted in an incapacity to either deal with variability or deal with it well. Some male individuals socialized in a patriarchal society rape and some adolescents from poor, urban, single-families chronically offend; however, most do not. In other words, there is individual variation within social contexts, and those differences may be better understood if criminologists begin to consider all pertinent angles or dimensions.

Although the studies in our review may appear to be firmly planted in the tradition of specialization and unidimensional thinking, they should be interpreted within the framework of Barak’s (1998) interdisciplinary criminology, where knowledges relevant to a behavioral outcome are treated as complements in an image expansion project. Understanding that each perspective offers a reality of behavior from a different, though interrelated angle, the objective is to develop a logical network of theories that will capture the most dimensions and provide the most accurate information about phenomena of interest. In this vein, our appraisal of knowledge from the field of neuroscience intends to elucidate the image of aggression and/or violence without supplanting other perspectives and paradigms. Our desire is not to reduce aggression and/or violence to brain functioning but to inform of advances in neurological analyses of emotion regulation and their importance to studies of that behavior.

It should be noted that the more comprehensive, interdisciplinary paradigm has been embraced by some criminologists linked to the biological sciences. In the 17 studies reviewed, researchers attempted to examine (or at least statistically controlled for) a variety of biological, psychological, and social correlates of aggressive and/or violent behavior and, in some cases, analyzed biopsychosocial interactions affecting behavior. Across studies, biological variables included history of head injury, substance use/abuse/dependence, diseases of the nervous system, left-handedness, body weight, height, head circumference, and sex. Psychological variables included the presence of psychological disorders (such as schizophrenia), indices of intellectual functioning (such as IQ scores), and performance-related motivational differences. Social variables included indices of psychosocial deprivation (such as physical and/or sexual abuse, extreme poverty, neglect, foster home placement, being raised in an institution, parental criminality, parental physical fights, severe family conflict, early parental divorce), family size, and ethnicity.

The benefits of integrating ideas or investigating an image from several angles in a research design is demonstrated in the neuroimaging studies provided. Raine, Lencz, et al. (2000), for example, found that prefrontal and autonomic deficits contributed substantially to the prediction of group membership (antisocial personality disorder vs. control group) over and above 10 demographic and psychosocial measures. The 10 demographic and psychosocial variables accounted for 41.3% of the variance. After the addition of three biological variables into the regression equation (prefrontal gray matter, heart rate, and skin conductance), amount of variance explained increased significantly to 76.7%, and the prediction of group membership increased from 73% to 88.5% classified correctly. These findings suggest that a more contextualized theoretical grasp of aggression and/or violence is possible when this behavior is conceptualized as multi-dimensional. When nature-nurture
dichotomies are countered by interdisciplinary image expansion, clues about individual variability emerge, and criminologists come closer to understanding the complexity of aggression and/or violence.

The compelling evidence about this behavior revealed in the reviewed neuroimaging studies is valuable, then, not because it allows for completely reliable predictions of behavioral outcomes, but because it makes the image of aggression and/or violence a little less murky. Moreover, when merged with existing knowledges, particularly ideas about social structures and social psychology (sociological model) and rational choice (legalistic model), such findings may spawn new visions of justice centered on prevention and treatment. Within an interdisciplinary framework that values neuroscience, virtually every essential sociological factor elaborated by criminologists, structural and processual, acquires a greater potential to explain aggression and/or violence and influence policy making. According to the works in our review, as well as other research in this area, all forms of child abuse and neglect, direct exposure to violence (including media violence), an unstable family life, poor parenting, lack of prenatal and perinatal services, individual drug use, maternal drug use during pregnancy, poor educational and employment structures, poverty, and even exposure to racism play a vital role in the production of aggression and/or violence. Thus, the inclusion of insights from neuroscience further legitimizes prevention strategies touted by advocates of the sociological paradigm, from social disorganization theory to self-control theory.

When aggression and/or violence is not prevented, the criminal justice system is granted responsibility for social control. . . . Drawing from empirical findings across disciplines and levels of analysis, a vision of therapeutic justice encourages the development of holistic treatment regimens that hold offenders to “scientifically rational and legally appropriate degree[s] of accountability” (Nygard, 2000, chap. 23, p. 12).

The potential for this approach to replace the utilitarian model lies in its continued ability to unveil the often-perplexing ways in which choice is structured. This facilitates an awareness that the legally appropriate and the scientifically rational are in unity. Human creativity is not ignored in this paradigm; however, the clearer image it provides points to an amalgam of limitations. When an individual is brought into the criminal justice system, an inter-disciplinarian seeks to examine those restrictions on behavior and to tailor treatments accordingly.

With varying levels of success, criminologists have sought to qualify choice and diminish the impact of legalistic factors on conceptions of justice since the advent of positivism in the 19th century. Assessments of measures associated with social psychology, psychology, and psychiatry, along with input implicating structural concerns, such as unemployment, have been utilized, and a plethora of interventions have evolved. Thus, cracks in the utilitarian mold of justice have accrued, laying the foundation for interdisciplinarity in thought and in treatment. Applied to aggression and/or violence, this translates into the implementation of treatment plans with multidimensional components, to include neurological techniques that address how brain dysfunction affects choice. Although not the sole neurological strategy, the intervention most consistently promoted is drug therapy. Several types of drugs, such as anti-convulsants, psychostimulants, and serotonergic agents, have been successful in reducing aggressive behavior. Inter-disciplinary thinkers should not be hesitant to consider using these pharmacological remedies when biopsychosocial indicators overwhelmingly suggest that an individual is at risk to violently recidivate, for it is a step in the direction of therapeutic justice.

Other than paradigmatic preferences disallowing an interdisciplinary consideration of aggressive and/or violent crimes and lack of funding, the largest obstacle in attaining therapeutic justice is the inability to predict future
behavior. When informed by neuroscience, classification and prediction instruments are fine-tuned. To illustrate, Robinson and Kelley (2000) discovered that, among probationers, indicators of brain dysfunction correlated with repeat violent offending, as opposed to repeat nonviolent offending and first-time offending. Birth complications, family abuse, head injury, parental drug use, abnormal interpersonal characteristics, and offender substance abuse were found to be risk factors for recidivism within this group. Given that it is estimated that less comprehensive prediction models reap false positives in approximately two thirds of all cases, added precision is welcome.

Still, prediction is not foolproof. Shortcomings in this area lead some to conclude that drug therapy and other invasive strategies are unwarranted. Before throwing in the towel, it should be acknowledged that pharmacological remedies already abound in the criminal justice system, along with many other intrusions. Knowledge from neuroscience merely allows for the targeted distribution of services to appropriate populations, a fruitful strategy given the scarcity of resources at the system’s disposal. Prevention strategies directed at alleviating environmental conditions that increase the probability for aggression and/or violence are optimal; however, criminologists should not dismiss neuropsychological individual-level interventions in cases where patterns of aggressive and/or violent criminality are detected. Converging lines of evidence suggest that those patterns are produced by a unique combination of external and internal risk factors, each of which is integral to the construction of treatment regimens intended to effect therapeutic justice.

Blind spots in the image of aggression and/or violence should not deter interventions where they hold promise for enhancing quality of life. It is unfair and unjust to those processed in the criminal justice system and to society at large for criminologists to ignore this evidence and the control strategies proposed.

Conclusion

Functional and morphometric neuroimaging have enhanced our understanding of the distributed neural networks that subserve complex emotional behaviors. Research emanating from affective, behavioral, and clinical neuroscience paradigms is converging on the conclusion that there is a significant neurological basis of aggressive and/or violent behavior over and above contributions from the psychosocial environment. In particular, and consistent with modern theories of emotion regulation, reduced prefrontal and/or subcortical ratios may predispose to impulsive aggression and/or violence. Further progress in the study of these behaviors will require a forensically informed, interdisciplinary approach that integrates neuropsychological and psychophysiological methods for the study of the brain, emotional processing, and behavior.

As this line of interdisciplinary research unfolds, it is vital that criminology and criminal justice begin to incorporate what is known about human behavior into its explanatory models, as well as its classrooms. Evidence suggests that brain structure and brain functioning do affect behavior, particularly aggressive and/or violent behavior. It is also the case that neuroscience offers means for curbing aggression and/or violence. Traditional criminology and criminal justice paradigms tend to sidestep these issues because of aversions to less dominant knowledge, especially biological programs of study. Biological insights are often dubbed Lombrosian, suggesting that some behavioral scientists retain notions of a born criminal easily identifiable using some magic test. Continued aversion to anything biological on these grounds is anachronistic and will hamper the development of theory and policy.

The problem is that neurobiological discovery has carried on with little to no input from criminology and criminal justice, and there is every reason to believe that the research
will progress. There is also reason to believe that the functioning of the criminal justice system will be affected by the findings produced. The general public is already being widely exposed to such advances through numerous television news clips and articles appearing in newspapers and weekly periodicals. If criminology and criminal justice wants to be relevant in more than a historical sense when it comes to theorizing about aggressive and/or violent behavior and formulating policies accordingly, it is imperative that the field embrace the interdisciplinary model.

**Implications for Practice, Policy, and Research**

**Practice**

Bridging the gap between nature and nurture, a biopsychosocial model for understanding aggression enhances the explanatory capacity of sociologically based criminological theories by accounting for individual variability within social contexts.

Insights derived from a biopsychosocial model offer the most promise in the realm of crime prevention, which entails devising holistic treatment strategies for those exposed to numerous risk factors.

**Policy**

The accuracy of risk classification devices, used extensively throughout the criminal justice process, may be enhanced by incorporating what is known about negative emotion regulation.

**Research**

Research reveals that other cortical and subcortical structures likely play a role in emotion regulation through their inextricable link to the prefrontal and medial-temporal regions. The complexity of this neural circuitry must be explored with greater precision.

**References**


DISCUSSION QUESTIONS

1. How might we make the case that the findings presented in this review support Agnew’s “super traits” theory discussed in Section 9?

2. What are the authors’ main arguments for “biopsychosocial” integration?

3. What do you think are the main obstacles to biopsychosocial integration?

READING

A Theory Explaining Biological Correlates of Criminality

Lee Ellis

In this article, Lee Ellis proposes a biosocial theory he calls the evolutionary neuroandrogenic theory (ENA), which purports to explain many of the correlates of criminal behavior. Two propositions form the theory’s foundation: an evolutionary proposition and a neurohormonal proposition. According to the first proposition, males have been favored for victimizing others because doing so has helped them to compete and acquire resources that they use to attract mates. The second proposition is concerned with identifying the neurochemistry underlying this evolved strategy. It maintains that male sex hormones—particularly testosterone—alter brain functioning in ways that promote competitive and victimizing types of behavior, which includes, but is not limited to, many types of criminality.

Despite growing evidence that biology plays an important role in human behavior, most theories of criminal behavior continue to focus on learning and social environmental variables. This article proposes a biosocial theory of criminality that leads one to expect variables such as age, gender and social status will be associated with offending in very specific ways. According to the theory, androgens (male sex hormones) have the ability to affect the brain in ways that increase the probability of what is termed competitive/victimizing behavior (CVB). This behavior is hypothesized to exist along a continuum, with “crude” (criminal) forms at one end and “sophisticated” (commercial) forms at the other. Theoretically, individuals whose brains receive a great deal of androgen exposure will be prone toward CVB. However, if they have normal or high capabilities to learn and plan, they

will transition rapidly from criminal to non-criminal forms of the behavior following the onset of puberty. Individuals with high androgen exposure and poor learning and planning capabilities, on the other hand, often continue to exhibit criminality for decades following the onset of puberty.

The Evolutionary Neuroandrogenic Theory of Criminal Behavior

The theory to be presented is called the *evolutionary neuroandrogenic theory* (ENA). The main types of offenses it attempts to explain are those that harm others, either by injuring them physically or by depriving them of their property. Two main propositions lie at the heart of ENA theory. The first addresses evolutionary issues by asserting that the commission of victimful crimes evolved as an aspect of human reproduction, especially among males. The second is concerned with identifying the neurochemistry responsible for increasing the probability of criminality among males relative to females. The theory maintains that sex hormones alter male brain functioning in ways that promote CVB, which is hypothesized to include the commission of violent and property crimes.

The concept of CVB is illustrated in Table 8.2. At one end of the continuum are acts that intentionally and directly either injure others or dispossess them of their property. In all societies with written laws, these obviously harmful acts are criminalized. At the other end of the CVB continuum are acts that make no profits on the sale of goods or services, although those who administer and maintain the organizations under which they operate usually receive much higher wages than do those who provide most of the day-to-day labor. In a purely socialist economy, the latter type of minimally competitive activities is all that is allowed; all other forms are criminalized. A capitalist economy, on the other hand, will permit profit-making commerce and often even tolerate commerce that involves significant degrees of deception. With the concept of CVB in mind, the two propositions upon which the theory rests can now be described.

The Evolutionary Proposition

Throughout the world, males engage in victimful crimes (especially those involving violence) to a greater extent than do females. To explain why, ENA theory maintains that female mating preferences play a pivotal role. The nature of this mating preference is that females consider social status criteria much more than males do in making mate choices, a pattern that has been documented throughout the world (Ellis, 2001). From an evolutionary standpoint, this female preference has served to increase the chances of females mating with males who are

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<th>Table 8.2</th>
<th>Continuum of Victimizer Behavior (Reflecting Competitive/Victimizer Tendencies)</th>
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<tr>
<td>The Continuum</td>
<td>very crude-------------------intermediate----------------------very sophisticated</td>
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<tr>
<td>Probability of Being Criminalized</td>
<td>virtually certain-----------------intermediate----------------------------------exceedingly unlikely</td>
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<td>Examples</td>
<td>Violent and property offenses (&quot;street crime&quot;)</td>
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reliable provisioners of resources, allowing females to focus more of their time and energy on bearing offspring. Another consequence has been that female choice has made it possible for males who are status strivers to pass on their genes at higher rates than males who are not. Such female preferences are found in other mammals, as evidenced by their mating more with dominant males than with subordinate males.

According to ENA theory, female preferences for status-striving males have caused most males to devote considerable time and energy to competing for resources, an endeavor that often victimizes others. In other words, natural selection pressure on females to prefer status-striving mates has resulted in males with an inclination toward CVB. ENA theory maintains that the brains of males have been selected for exhibiting competitive/victimizing behavior to a greater extent than the brains of females, and that one of the manifestations of this evolved sex difference is that males are more prone than females toward victimful criminality.

Theoretically, the same natural selection pressure that has resulted in the evolution of CVB has also favored males who flaunt and even exaggerate their resource-procuring capabilities. More unpleasant consequences of the female bias for resource provisioning mates are male tendencies to seek opportunities to circumvent female caution in mating by using deceptive and even forceful copulation tactics. This implies that rape will always be more prevalent among males than among females. ENA theory also leads one to expect complex social systems to develop in order to prevent crime victimization. In evolutionary terms, these systems are known as counter-strategies. An example of a counter-strategy to crude forms of CVB is the evolution of the criminal justice system.

As with any theory founded on neo-Darwinian thinking, ENA theory assumes that genes are responsible for substantial proportions of the variation in the traits being investigated. In the present context, the average male is assumed to have a greater genetic propensity toward CVB than is true for the average female. However, this assumption must be compromised with the fact that males and females share nearly all of their genes. Consequently, the only possible way for the theory to be correct is for some of the genes that promote criminality (along with other forms of CVB) to be located on the one chromosome that males and females do not share—the Y-chromosome.

### The Neuroandrogenic Proposition

The second proposition of ENA theory asserts that three different aspects of brain functioning affect an individual’s chances of criminal offending by promoting CVB. Two additional neurological factors help to inhibit offending by speeding up the acquisition of sophisticated forms of CVB. Testosterone’s ability to affect brain functioning in ways that promote CVB is not simple, but most of the complexities will not be considered here. The main point to keep in mind is that testosterone production occurs in two distinct phases: the organizational (or perinatal) phase and the activational (or postpubertal) phase. Most of the permanent effects of testosterone effects occur perinatally. If levels of testosterone are high, the brain will be masculinized; if they are low, the brain will remain in its default feminine mode.

ENA theory asserts that androgens increase the probability of CVB by decreasing an individual’s sensitivity to adverse environmental consequences resulting from exhibiting CVB. This lowered sensitivity is accomplished by inclining the brain to be suboptimally aroused. Suboptimal arousal manifests itself in terms of individuals seeking elevated levels of sensory stimulation and having diminished sensitivity to pain.

The second way androgens promote CVB according to ENA theory is by inclining the limbic system to seize more readily, especially under
stressful conditions. At the extreme, these seizures include such clinical conditions as epilepsy and Tourette's syndrome. Less extreme manifestations of limbic seizing are known as episodic dyscontrol and limbic psychotic trigger. These latter patterns include sudden bursts of rage and other negative emotions, which often trigger forceful actions against a perceived provocateur.

Third, ENA theory asserts that androgen exposure causes neocortical functioning to be less concentrated in the left (language-dominated) hemisphere and to shift more toward a right hemispheric focus. As a result of this so-called rightward shift in neocortical functioning, males rely less on language-based reasoning, emphasizing instead reasoning which involves spatial and temporal calculations of risk and reward probabilities. Coinciding with this evidence are intriguing new research findings based on functional magnetic resonance imaging (fMRI) which suggest that empathy-based moral reasoning occurs primarily in the left hemisphere. Predictably, empathy-based moral reasoning seems to be less pronounced in males than in females. Such evidence suggests that empathy-based moral reasoning is more likely to prevent victimful criminality than so-called justice-based moral reasoning.

Theoretically, the three androgen-enhanced brain processes just described have evolved in males more than in females because these processes contribute to CVB. Furthermore, competitive/victimizing behavior has evolved in males more than in females because it facilitates male reproductive success more than it facilitates female reproductive success.

**Inhibiting Criminal Forms of Competitive/Victimizing Behavior**

Regarding the inhibiting aspects of brain functioning, two factors are theoretically involved. One has to do with learning ability and the other entails foresight and planning ability. According to ENA theory, the ability to learn will correlate with the rapidity of male transitioning from crude to sophisticated forms of CVB. This means that intelligence and other measures of learning ability should be inversely associated with persistent involvement in criminal behavior. Likewise, neurological underpinnings of intelligence such as brain size and neural efficiency should also correlate negatively with persistent offending. These predictions apply only to persistent victimful offending, with a much weaker link to occasional delinquency and possibly none with victimless criminality.

The frontal lobes, especially their prefrontal regions, play a vital role in coordinating complex sequences of actions intended to accomplish long-term goals. These prefrontal regions tend to keenly monitor the brain's limbic region, where most emotions reside. Then the prefrontal regions devise plans for either maximizing pleasant emotions or minimizing unpleasant ones. In other words, for the brain to integrate experiences into well-coordinated and feedback-contingent strategies for reaching long-term goals, the frontal lobes perform what has come to be called executive cognitive functioning. Moral reasoning often draws heavily on executive cognitive functioning since it often requires anticipating the long-term consequences of ones actions.

Factors that can impact executive cognitive functioning include genetics, prenatal complications, and various types of physical and chemical trauma throughout life. According to ENA theory, inefficient executive cognitive functioning contributes to criminal behavior. Similar conclusions have been put forth in recent years by several other researchers.

To summarize, ENA theory asserts that three aspects of brain functioning promote competitive/victimizing behavior, the crudest forms of which are victimful crimes. At least partially counterbalancing these androgen-promoted tendencies are high intelligence and efficient executive cognitive functioning. These latter two factors affect the speed with which individuals
quickly learn to express their competitive/victimizing tendencies in sophisticated rather than crude ways. Sophisticated expressions are less likely to elicit retaliation by victims, their relatives, and the criminal justice system than are crude ones. Males with low intelligence and/or with the least efficient executive cognitive functioning will therefore exhibit the highest rates of victimful criminal behavior.

**Correlates of Criminal Behavior**

Twelve biological correlates of crime with special relevance to ENA theory (testosterone, mesomorphy, maternal smoking during pregnancy, hypoglycemia, epilepsy, heart rate, skin conductivity, cortisol, serotonin, monoamine oxidase, slow brainwave patterns, and P300 amplitude) are discussed below.

**Testosterone** ENA theory predicts that correlations will be found between testosterone and CVB. However, the nature of these correlations will not involve a simple one-to-one correspondence between an individual’s crime probability and the amount of testosterone in his/her brain at any given point in time. Earlier, a distinction was made between the organizational and activational effects of testosterone on brain functioning, and that the most permanent and irreversible effects of testosterone occur perinatally. For this reason alone, testosterone levels circulating in the blood stream or in saliva following puberty may have little direct correlation with neurological levels, especially within each sex. Therefore, one should not expect to find a strong correlation between blood or saliva levels of testosterone among, say, 20-year-old males and the number of offenses they have committed even though testosterone levels in the brain at various stages in development are quite influential on offending probabilities.

Numerous studies have investigated the possible relationship between blood levels or saliva levels of testosterone and involvement in criminal behavior, and most have found modest positive correlations (Maras et al. 2003). Additional evidence of a connection between testosterone and aggressive forms of criminality involves a recent study of domestic violence, where offending males had higher levels of saliva testosterone than did males with no history of such violence (Soler et al. 2000).

Overall, it is safe to generalize that circulating testosterone levels exhibit a modest positive association with male offending probabilities, particularly in the case of adult violent offenses. According to ENA theory, males are more violent than females, not because of cultural expectations or sex role training, but mainly because of their brains being exposed to much higher levels of testosterone than the brains of females.

**Mesomorphy** Body types exist in three extreme forms. These are sometimes represented with a bulging triangle. Most people are located in the center of the triangle, exhibiting what is termed a basically balanced body type. At one corner of the triangle are persons who are extremely muscular, especially in the upper body, called mesomorphs. Ectomorphs occupy a second corner. Individuals with this body type are unusually slender and non-muscular. In the third corner, one finds endomorphs, individuals who are overweight and have little muscularity.

Studies have consistently revealed that offending probabilities are higher among individuals who exhibit a mesomorphic body type than either of the two other extreme body types (e.g., Blackson & Tarter 1994). ENA theory explains this relationship by noting that testosterone affects more than the brain; it also enhances muscle tissue, especially in the upper part of the body.

**Maternal Smoking During Pregnancy** There is considerable evidence that maternal smoking may lead to an elevated probability of offspring becoming delinquent (e.g., Rasanes et al. 1998). ENA theory assumes that fetal exposure to
carbon monoxide and other neurotoxins found in cigarette smoke disrupt brain development in ways that adversely affects IQ or executive cognitive functioning, thereby making it more difficult for offspring to maintain their behavior within prescribed legal boundaries. However, it is possible that genes contributing to nicotine addiction may also contribute to criminal behavior. In fact, a recent study reported that the link between childhood conduct disorders (a frequent precursor to later criminality) and maternal smoking was mainly the result of mutual genetic influences (Maughan et al. 2004).

**Hypoglycemia** Glucose, a type of natural sugar, is the main fuel used by the brain. The production of glucose is largely regulated by the pancreas in response to chemical messages from a portion of the brain called the hypothalamus. When the hypothalamus senses that glucose levels are becoming too high or too low, it sends chemical instructions to the pancreas to either curtail or increase production of glucose by regulating the amount of insulin released into the blood system. In most people, this feedback regulatory process helps to maintain brain glucose at remarkably stable levels. For a variety of reasons, some people have difficulty stabilizing brain glucose levels. These people are said to be hypoglycemic. Dramatic fluctuations in brain glucose can cause temporary disturbances in thoughts and moods, with the most common symptoms being confusion, difficulty concentrating, and irritability.

Studies have indicated that hypoglycemia is associated with an elevated probability of crime, especially of a violent nature (e.g., Virkkunen 1986). To explain such a connection, ENA theory draws attention to the importance of maintaining communication between the various parts of the brain in order to control emotionality. In particular, if the frontal lobes receive distorted signals from the limbic system, bizarre types of behavioral responses sometimes result, including responses that are violent and antisocial.

**Epilepsy** Epilepsy is a neurological disorder typified by seizures. These seizures are tantamount to “electrical storms” in the brain. While people vary in genetic susceptibilities, seizures are usually induced by environmental factors such as physical injuries to the brain, viral infections, birth trauma, and exposure to various chemicals.

The main behavioral symptoms of epilepsy are known as convulsions (or fits), although not all epileptics have full-blown convulsive episodes. Mild epileptic episodes may manifest themselves as little more than a momentary pause in an ongoing activity accompanied by a glazed stare. Seizures that have little to no noticeable debilitating effects on coordinated movement are called subconvulsive (or subclinical) seizures. Studies of human populations have shown that epilepsy affects only about one in every 150 to 200 persons. In prison populations, however, the prevalence of epilepsy is around one in 50, at least three times higher than in the general population (e.g., Mendez et al. 1993).

ENA theory can explain the links between epilepsy and offending by noting that very basic and primitive emotional responses sometimes emanate from the limbic region of the brain. While seizures in motor control centers are most likely to receive a diagnosis of epilepsy, seizures in the limbic region could provoke very basic survival instincts.

**Resting Heart and Pulse Rates** Heart and pulse rates rise in response to strenuous exercise along with stressful and frightening experiences. Studies have shown that on average, the resting heart rate and pulse rate of convicted offenders are lower than those of persons in general (e.g., Mezzacappa et al. 1997:463). ENA theory would account for these relationships by stipulating that both low heart and low pulse rates are physiological indicators of suboptimal arousal. Such arousal levels should incline individuals to seek more intense stimulation and to tolerate unpleasant environmental feedback to a greater
extent than individuals with normal or superoptimal arousal under most circumstances.

**Skin Conductivity (Galvanic Skin Response)**
Sweat contains high concentrations of sodium, which is a good electrical conductor. A device called a *Galvanic Skin Response* (GSR) meter was developed nearly a century ago to monitor palmer sweat. The GSR works by measuring electrical impulses passing through our bodies from one electrode to another. Thus, by putting one’s fingers on two unconnected electrodes of a GSR device, one completes an electrical circuit through which imperceptible amounts of electricity flows. Temperature obviously affects how much people sweat, but so too do emotions. The more intense one’s emotions become (especially those of fear and anger), the more one will sweat, and thus the stronger will be the readings on the GSR meter.

Numerous studies have examined the possibility that persons with the greatest propensities toward criminal behavior have distinctive skin conductivity patterns. These studies suggest that offenders exhibit lower skin conductivity under standard testing conditions than do people in general (e.g., Buikhuisen et al. 1989; Raine et al. 1996). As in the case of heart and pulse rates, ENA theory can account for such findings by hypothesizing that low GSR readings especially under stressful testing conditions are another indication of suboptimal arousal.

**Cortisol**
So-called *stress hormones* are secreted mainly by the adrenal glands during times of anxiety, stress, and fear. The stress hormone that has been investigated most in connection with criminality is cortisol. Most of these studies have suggested that offenders have below normal levels (e.g., Lindman et al. 1997). As with heart rates and skin conductivity, one could anticipate a low cortisol-high criminality relationship by assuming that low cortisol production even in the face of stress is another indicator of suboptimal arousal. This would suggest that offenders are less intimidated by threatening aspects of their environments than are persons in general.

**Serotonin**
Suggesting that persons with the greatest propensities toward criminal behavior have distinctive skin conductivity patterns. These studies suggest that offenders exhibit lower skin conductivity under standard testing conditions than do people in general (e.g., Buikhuisen et al. 1989; Raine et al. 1996). As in the case of heart and pulse rates, ENA theory can account for such findings by hypothesizing that low GSR readings especially under stressful testing conditions are another indication of suboptimal arousal.

**Monoamine Oxidase**
(MAO) is an enzyme found throughout the body. Within the brain, MAO helps to break down and clear away neurotransmitter molecules (including serotonin), portions of which often linger in the synaptic gap after activating adjacent nerve cells. Studies indicate that MAO activity is unusually low among offenders (e.g., Alm et al. 1996; Klinteberg 1996). ENA draws attention to the fact that low MAO activity seems to be related to high levels of testosterone. Furthermore, low MAO brain activity may interfere with the brain’s ability to manufacture or utilize serotonin.

**Brain Waves and Low P300 Amplitude**
Brain waves are measured using electrodes placed on the scalp. These electrodes can detect electrical activity occurring close to the surface of the brain.
fairly clearly. Despite their complexity, brain waves can be roughly classified in terms of ranging from being rapid and regular (alpha brain waves) to being slow and irregular (delta brain waves). Most studies based on electroencephalographic (EEG) readings have found that offenders have slower brain waves than do persons in general (e.g., Petersen et al. 1982).

Unlike traditional brain wave measurement, modern computerized brain wave detection is able to average responses to dozens of identical stimuli presented to subjects at random intervals. This reveals a distinctive brain wave pattern or “signature” for each individual. Nearly everyone exhibits a noticeable spike in electrical voltage, interrupted by a “dip” approximately one-third of a second following presentation of test stimuli. This is called the P300 amplitude of an event-related evoked potential. From a cognitive standpoint, the P300 amplitude is thought to reflect neurological events central to attention and memory.

While research has been equivocal thus far in the case of criminality, several studies have found a greater dip in P300 responses by individuals diagnosed with antisocial personality disorder than is true for general populations (see Costa et al. 2000). ENA theory can account for slower EEG patterns among offenders and a P300 decrement among persons with antisocial behavior by again focusing on suboptimal arousal. From a neurological standpoint, both slow brain waves and a tendency toward a greater than normal P300 decrement can be considered symptomatic of suboptimal arousal. If ENA theory is correct, both of these conditions will be found associated with elevated brain exposure to testosterone.

Summary and Conclusions

Unlike social environmental theories, the evolutionary neuroandrogenic (ENA) theory can account for statistical associations between biological variables and criminal behavior. Furthermore, ENA theory predicts the universal concentration of offending among males between the ages of 13 and 30, patterns that strictly environmental theories have always had difficulty explaining. As its name implies, ENA theory rests on two over-arching assumptions. The first assumption is an extension of Darwin’s theory of evolution by natural selection. It maintains that males on average exhibit CVB more than females because females who prefer to mate with such males increase their chances of having mates who are competent provisioners of resources. These female biases have evolved because females who have had the assistance of competent provisioners have left more offspring in subsequent generations than other females. No comparable reproductive advantage comes to males who select mates based on resource procurement capabilities.

Some forms of CVB are crude in the sense of requiring little learning, nearly all of which are either assaultive or confiscatory in nature. Other forms are sophisticated in the sense that they require complex learning and involve much more subtle types of “victimization.” A major expression of sophisticated competitive/victimizing behavior involves profitable business ventures and/or the management of large organizations. In most societies, these expressions are tolerated and even encouraged. However, the vast majority of people in all societies condemn the crudest expressions of CVB, and, in all literate societies, the criminal justice system has evolved to punish such behavior.

The theory’s second assumption is that genes on the Y-chromosome have evolved which cause male brains to exhibit higher rates of competitive/victimizing behavior than female brains. These genes operate in part by causing would-be ovaries to develop instead into testes early in fetal development. Once differentiated, the testes produce testosterone and other sex hormones, which have three hypothesized effects
upon brain functioning, all of which promote CVB. The three effects are termed suboptimal arousal, seizing proneness, and a rightward shift in neocortical functioning. Furthermore, two neurological processes are hypothesized to help individuals shift from crude to sophisticated forms of competitive/victimizing behavior. These are learning ability (or intelligence) and executive cognitive functioning (or planning ability). The better one’s learning ability or executive functioning, the quicker he/she will transition from crude to sophisticated forms of the behavior.

To illustrate the theory’s predictive power, the second portion of this article reviews evidence regarding several biological correlates of criminal behavior. For all of these correlates, the theory was able to explain their apparent relatedness to criminality. Proponents of critical theory, differential association theory, control theory, etc. cannot explain these correlates. They must simply ignore them. Overall, ENA theory should help move criminology beyond strictly social environmental theories toward a new, more variable-rich paradigm. From the theory’s perspective, criminality results from a complex interaction of evolutionary, biological, learning, and social environmental factors.

References


DISCUSSION QUESTIONS

1. All three readings in this section have appealed for the integration of biologically informed and strictly environmental theories of criminology. Given the cascade of evidence supporting the role of biological factors in criminality, why do you think some criminologists still resist integration?

2. How would you go about testing ENA theory?

3. What is the primary role of testosterone vis-à-vis criminal behavior?