Biosocial Theories of Crime

Edited by
Kevin M. Beaver and
Anthony Walsh

The Library of Essays in Theoretical Criminology

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The Library of Essays in Theoretical Criminology
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Edited by

Kevin M. Beaver

Florida State University, USA

and

Anthony Walsh

Boise State University, USA

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Series Preface

Because of its pervasive nature in our mass mediated culture, many believe they are experts in understanding the reasons why offenders violate the law. Parents and schools come high on the public's list of who to blame for crime. Not far behind are governments and legal systems that are believed to be ineffective at deterring offenders – too many legal protections and too few serious sentences. Some learn how to behave inappropriately as children, while others are said to choose crime because of its apparent high reward/low cost opportunity structure. Yet others hang out with the wrong crowd, or live in the wrong neighborhood, or work for the wrong corporation, and may get their kicks from disobeying rules in the company of like-minded others. A few are seen as evil, insane or just plain stupid. While such popular representations of the causes of crime contain glimpses of the criminological reality, understanding why people commit crime is a much more complex matter. Indeed, for this reason the quest to establish the causes of crime has been one of the most elusive searches confronting humankind.

Since the mid-19th century, following the advent of Charles Darwin's *The Origin of Species*, those who sought scientific knowledge to understand crime abandoned philosophical speculation and economic reductionism. In its place they founded the multifaceted interdisciplinary field of criminology. Unlike criminal law and legal theory that explored the logic of prohibitions against offensive behavior, and in contrast to criminal justice that examined the nature and extent of societies' responses to crime through systems of courts, police and penology, criminology's central focus is the systematic examination of the nature, extent and causes of crime. Criminological theory as a subset of criminology, comprises the cluster of explanation seeking to identify the causes or etiology of crime. This *Library of Essays in Theoretical Criminology* is designed to capture the range and depth of the key theoretical perspectives on crime causation.

While there are numerous criminological theories, most can be clustered into 10 or 12 theoretical perspectives. Moreover, each of these broad theoretical frameworks is, itself, rooted in a major academic discipline. The most predominant disciplines influencing criminological theory include: economics, anthropology, biology, psychology, geography, sociology, politics, history, philosophy, as well as the more recent multi-disciplinary fields such as gender studies, critical race studies and postmodernist social theory.

Criminological theories are rarely discrete. Although they often emphasize a particular disciplinary field, they also draw on aspects of other disciplines to strengthen their explanatory power. Indeed, since 1989 a major development in criminological theory has been the emergence of explicitly integrative theoretical approaches (See Gregg Barak, *Integrative Criminology*; Ashgate, 1998). Integrative/interdisciplinary approaches bring together several theories into a comprehensive explanation, usually to address different levels of analysis; these range from the micro-individual and relational approaches common in biology and psychology, to the meso-level institutional explanations that feature in sociological analysis, to the macro-level geographical, political, cultural and historical approaches that deal with

societal and global structures and patterns. Recent developments in criminological theory have seen an acceleration of this trend compared with that of single disciplinary explanations of crime (See Stuart Henry and Scott Lukas, *Recent Developments in Criminological Theory*; Ashgate, 2009).

Although there are now over 20 English-language criminological theory textbooks and numerous edited compilations, there is a need to make available to an international audience a series of books that brings together the best of the available theoretical contributions. The advantage of doing this as a series, rather than a single volume, is that the editors are able to mine the field for the most relevant essays that have influenced the present state of knowledge. Each contribution to the series thus contains many chapters, each on a different aspect of the same theoretical approach to crime causation.

In creating this series I have selected outstanding criminologists whose own theories are discussed as part of the literature and I have asked each of them to select a set of the best journal essays to represent the various facets of their theoretical framework. In doing so, I believe that you will receive the best selection of essays available together with an insightful and comparative overview placing each essay in the context of the history of ideas that comprises our search to better understand and explain crime and those who commit it.

STUART HENRY
Series Editor
School of Public Affairs
San Diego State University, USA

Introduction

There is virtually an endless supply of theoretical explanations about why some people become chronic criminals. For the past eighty years or so, the most dominant explanations advanced by criminologists have focused almost exclusively on environmental factors such as the family, neighbourhood and exposure to delinquent peers. These have ranged from macro-level societal structural and cultural explanations, through meso-level organizational and community explanations to micro-level social learning and social interactive explanations. In addition to emphasizing the role of social factors, most criminological theories either ridiculed or ignored the possibility that biological factors could contribute to criminal behaviour. The end result is that the field of criminology has traditionally been a discipline that effectively eliminated any scientific inquiry related to the connection between biology and crime (Walsh and Ellis, 2004). But there is good reason to believe that the tide is beginning to turn, and that these predominantly social explanations for crime are slowly being augmented by biosocial theories that emphasize the interplay between biological and environmental risk factors in the production of antisocial behaviours. We emphasize that the history of criminology is additive; theoretical frameworks are never extinguished and replaced by others. Biosocial criminology wants to strengthen traditional criminological theories by adding relevant concepts and methodologies to them; it does not seek to replace them.

Criminologists and other social scientists have historically viewed biosocial theories of crime with scepticism, trepidation and even in some cases with outright antagonism (although psychological and developmental theories have always had a place). A large part of this opposition has nothing to do with the merits of biosocial criminology, but rather is the result of a misunderstanding of the biosocial approach. For the most part, criminologists have been trained as sociologists, earning their doctoral degrees from sociology departments whose faculty tend to deny the possibility that biology plays any role in the aetiology of human behaviour. Happily this has changed somewhat since the 1980s with the growth of multidisciplinary criminal justice departments; indeed the top-ranked doctoral programmes in the USA have a range of disciplines represented, such as John Jay College of Criminal Justice, University of California at Irvine's Criminology, Law, and Society programme, and Northeastern University's School of Criminal Justice.

Nevertheless, the majority of newly minted criminologists were taught in sociology programmes and thus know virtually nothing about the nexus between crime and biological processes (Wright *et al.*, 2008). Any 'biology' they may have been exposed to is taught by sociologists who do not understand its most basic principles and tends to be nothing but second-hand criticisms of the likes of Lombroso. A recent survey of 770 PhD-level criminologists (Cooper, Walsh and Ellis, in press) found that the modal number of sociology classes they had taken was 10; the modal number of biology classes was zero. As a result, a vicious cycle ensues in sociological criminology where criminologists teach their students nothing about biology (or worse yet, teach recycled falsehoods and distorted interpretations of ancient biological research) and these students then go on to teach future generations of

sociology students nothing about biology. This cycle – which is highly evident in contemporary criminology graduate programmes worldwide – has culminated in any semblance of valid biology essentially being censored from the curriculum.

Many sociologically trained criminologists often tie modern biosocial criminology to archaic biological theories that were advanced near the turn of the nineteenth century. These early biological theories were the exact opposite of what is currently found in contemporary biosocial criminology in that they focused only on biology and ignored the influence of the environment. Because of these early theorists' narrow emphasis on biology, their theories are viewed in contemporary textbooks as pre-deterministic – that is, each person's personality and character, and hence much of their behaviour (criminal or otherwise) is seen as preordained at conception by their genetic inheritance. This logic was supposedly used as leverage to legitimize the eugenics movement, where criminals and other vulnerable populations were subjected to forced sterilization. By preventing criminals from propagating their biological characteristics, biological risk factors would eventually be eliminated from the population and crime would cease to exist. Ironically, the eugenics movement was supported by some leftist sociologists (especially Marxists) and was informed by sociological theories as well as biological theories. Eugenics was an integral part of the left's programme for human perfectibility (Abu El-Haj, 2007), and as an early Marxist maintained: 'unless the socialist is a eugenicist as well, the socialist state will perish from racial degradation' (quoted in Paul, 1984, p. 568). Many mainstream sociologists were critical of this Marxist position in sociology; we bring it up only to emphasize that eugenics was not just the darling of right-wing biologists.

Unlike theories that focused only on biology and ignored the influence of the environment, current biosocial theories are much more sophisticated, are scientifically defensible and recognize the importance of both biology and the environment, which is why this volume is entitled *Biosocial Theories of Crime* rather than *Biological Theories of Crime*. This is a far cry from the nature versus nurture debate that has impeded scientific progress in the social sciences. Outside of criminology, the nature versus nurture debate is dead and buried, but there is still an element within the discipline that keeps digging up its rotting corpse. This is surprising because a wealth of empirical research has revealed that all human behaviour is due to biological and environmental factors working independently and interactively (Rutter, 2006), but although this is probably accepted by many criminologists in theory, few actually accept it in practice. Biosocial criminologists seek to integrate these empirical findings into a perspective that unites the dual role of biology and the environment in the production of human phenotypic variation. In fact, contemporary biosocial criminology has been called a 'biologically informed environmental approach' to crime (Walsh and Beaver, 2009, p. 9).

Statements on the Biosocial Perspective

This volume contains some of the most influential essays on biosocial criminology written by the leading experts in the field. These essays cover a wide range of the biosocial terrain and are organized around four main themes. Part I sets the stage for the rest of the book by including five essays that describe, explain and advance various theoretical statements from the biosocial perspective. Since most sociologically oriented criminologists know very little about biology, one of the obstacles facing biosocial criminologists is to create a 'common language' accessible to those criminologists without a background in biology. Chapter 1, by

Diana Fishbein, does exactly this through a comprehensive overview of biological concepts and the findings generated from biosocial research. Fishbein also discusses how biological findings can be incorporated into mainstream criminological theories to create biosocial explanations of criminal involvement.

Biosocial theories of human behaviour have been attacked on the grounds that they are racist. According to this argument, if biological factors explain crime, and if there are racial differences in criminal involvement, then it stands to reason that there must be biological differences among different races. Douglas Massey, himself a sociologist, tackles this issue head-on in Chapter 2 by examining how segregation and stratification can adversely harm African-Americans through biosocial processes. His basic argument is that minority groups are differentially exposed to stressful situations that have harmful effects on normal human biological functioning. It is via these effects on biological functioning that social structural characteristics exert their influence on behavioural outcomes, such as violence. Massey concludes that

> In the past, many social scientists have shunned biologically grounded explanations of racial gaps for fear of legitimizing racist theories or out of a fear of being labeled a racist; but an appreciation of the biosocial mechanisms by which racial differentials are produced turns these fears on their heads … In an era when scientific understanding is advancing rapidly through interdisciplinary efforts, social scientists in general – and sociologists in particular – must abandon their hostility to biological science and incorporate its knowledge and understanding into their work. (p. 64)

The biosocial criminological perspective adheres to Massey's suggestion and shows that this theoretical framework can elucidate the complex processes that might be able to explain some of the 'brute facts' of crime, including racial disparities in violent behaviour.

The next two essays advance biosocial theories of criminal and delinquent behaviour. Chapter 3 is by Terrie E. Moffitt, who has been highly influential in shaping research from a diverse range of disciplines, including criminology, psychology, psychiatry and child development. Her theory, widely known as the 'developmental taxonomy', which virtually created the field of developmental and life-course criminology, relies on biological factors such as neuropsychological functioning and temperament, as well as social factors such as the family and social mimicry to explain adolescent delinquency and career criminality. In Chapter 4 Anthony Walsh discusses the various ways that biological concepts could be fused together with a highly influential mainstream criminological theory – strain theory – to create a biosocial theory of crime and delinquency. The key contribution of these two essays is that they show the importance of relying on both biological and environmental factors when creating logical theoretical perspectives on crime.

Part I concludes with Chapter 5 by Nicole Hahn Rafter, who discusses the historical development and future of biosocial criminology by focusing on the eminent British psychologist and scholar Hans Eysenck. In this unique essay, Rafter describes the contributions that Eysenck made to the understanding of crime. She concludes by painting a bright future for biosocial research in criminology due, in large part, to Eysenck's efforts. In the words of Rafter: 'Eysenck made the first thoroughgoing effort of the 20th century to formulate a biologically based theory of crime, setting in motion a return to biocriminology that continues into the present and promises to play an increasingly large role in the criminological future' (p. 144). We are in agreement that a multidisciplinary biosocial criminology, one that is not dominated by any particular academic discipline, is the way forward.

In the remaining three sections of the volume, three broad biological approaches to the study of crime are presented: genetic, evolutionary and neuroscience. Each of these perspectives will be introduced in the following pages, but it is important to note that the common theme uniting them is that they all seek to explain criminal behaviour by examining the intersection of biological and environmental factors.

Genetics and Crime

Because of sociological criminology's ignorance and distrust of biology, it is difficult to determine the extent to which genes contribute to criminal and delinquent behaviours when perusing the criminological literature. Research conducted by behavioural geneticists, however, routinely examines the genetic and environmental basis of a wide range of behaviour, including antisocial behaviour, although not all antisocial behaviour is criminal behaviour. Geneticists use two main types of methodologies – twin-based and molecular genetic methodologies – to explore the influence of genetic factors on behaviour (Plomin *et al.*, 2008). In the twin-based methodology, the phenotypic similarity of monozygotic (MZ) twin pairs is compared to the phenotypic similarity of dizygotic (DZ) twin pairs. MZ twins are genetic clones of each other who are also reared in the same home environments and by the same parents. DZ twins, in contrast, share only about 50 per cent of their genetic material; however, like MZ twins, they also share the same home environments and are reared by the same parents. There are rare cases in which twin pairs are reared apart by adoptive parents, which provide another method of teasing apart the influence of genes and environment – the adoption method.

Twin-based methodologies provide direct estimates of the proportion of variance in the phenotype that is accounted for by genetic factors (referred to as heritability coefficients – h^2). This methodology also estimates the proportion of phenotypic variance accounted for by environmental factors since $1 - h^2$ = the environmental coefficient. Behavioural geneticists distinguish between two different types of environments: shared and non-shared (Plomin and Daniels, 1987). Shared environments are environments common to all siblings, such as the neighbourhood, religion, diet, socioeconomic status and parental socialization tactics. Shared environments make siblings phenotypically more similar to each other. Non-shared environments are environments that are unique to each sibling in the same household. Typically, non-shared environments are equated with extrafamilial factors, such as different peer groups and teachers, and idiosyncratic experiences. Non-shared environments are also found within the home, such as differential parental treatment, although differences in parental behaviour are likely influenced by the child's evocative behaviour. Whereas shared environments work to make siblings similar to each other, non-shared environments exert their influence by making siblings different from each other. Together, heritability, the shared environment and the non-shared environment account for 100 per cent of the variance in any measured (phenotypic) trait.

Although the precise estimates of genetic and environmental effects vary across studies, on average genetic factors account for about 50 per cent of the variance in antisocial behaviour, shared environmental factors account for about 10 per cent of the variance and the remaining 40 per cent of variance is attributable to non-shared environmental factors. These figures have been supported by mounds of methodologically rigorous studies, by four meta-analyses (Ferguson, 2010; Mason and Frick, 1994; Miles and Carey, 1997; Rhee and Waldman, 2002)

and by large literature reviews (Moffitt, Chapter 11 this volume). Clearly, these results are robust and are not easily explained away as a methodological or statistical artefact.

The twin-based approach is explained in a very clear and cohesive manner in the first essay in Part II of the volume. Written by Lisabeth DiLalla, Chapter 6 moves beyond discussing the twin-based methodology and explains other types of methodologies that are also used to explore the genetic and environmental effects on antisocial behaviours. DiLalla then provides a detailed overview of the research that has employed these types of genetically sensitive methodologies to the study of aggression and delinquency. According to DiLalla, the results of these studies point to the inescapable conclusion that genetic factors are critically important to the development of antisocial behaviour of all kinds, including criminal behaviour.

Chapter 7, by Terrie E. Moffitt, also reviews the research that has examined the genetic and environmental effects on a wide array of antisocial behaviours. Instead of discussing only the findings of genetic research, Moffitt's essay also highlights the ways that genetic methodologies can be used to provide more accurate tests of hypotheses linking environmental factors to antisocial phenotypes. This is particularly important to traditional criminologists because Moffitt shows how their environmentally oriented research can be augmented and improved by using genetically sensitive methodologies.

Gene–Environment Interactions and Criminal Behaviour

There are two major drawbacks to twin-based studies: (1) twin samples are extremely difficult to obtain, and (2) they do not provide any information about the specific genes that account for the variance in the antisocial phenotypes. One way to overcome these limitations is to analyse data sets that include measured genes – known as molecular genetic studies. Molecular genetic studies are able to examine whether variation in certain genes maps to variation in various forms of antisocial behaviour. Results garnered from these studies provide hard, empirical evidence of the role that individual genes play in the development of behavioural outcomes. In order to understand the gene–behaviour nexus, it is imperative to understand what a gene is, what it does and how it relates to behaviour. A gene is a sequence of deoxyribonucleic acid (DNA) that codes for the production of proteins, such as enzymes and hormones. Genes do not directly cause antisocial behaviours or any other complex behaviour; rather it is the products of these genes (for example enzymes, hormones, neurotransmitters) that make certain behaviours more or less likely to emerge in certain environments. In some environments, such as those typified by high levels of stress, certain gene products may incline a person to commit a violent act, but in a different environment the same gene products may not contribute to antisocial behaviour. Genes exert only indirect effects on behaviour – that is, the genetic effect surfaces only when paired with a particular environment. This process is known as a gene–environment interaction.

Far from people being slaves to genes, genes are at the beck and call of people as they meet environmental challenges. If an environmental stimulus requires a conscious decision, such as whether to fight, talk, flee or scratch a sexual itch, proteins are produced to help us to do what we decide to do. Genes do not determine how we act; they provide us the necessary biological tools to do so. This is not to say that variability in genetic polymorphisms (different forms a gene might take) does not bias us to act in certain ways – it does, but genetic effects ebb and flow at different stages of development and within different environmental contexts.

Responses to environmental stimuli may be largely determined by the subjective appraisal of a situation, but that appraisal is dependent on a causal chain involving prior learning, enduring personal traits, developmental history, genetic inheritance and ultimately the evolutionary history of the species (Walsh and Beaver, 2009).

Gene–environment interaction is nothing more mysterious than the common-sense notion that different genotypes will interact with and respond to their environments in different ways – that is, people are differentially sensitive to identical environmental influences. The concept is captured by the saying 'the heat that melts the butter hardens the egg'. Gene–environment interactions are thought to play a pivotal role in the production of antisocial behaviours, and emerging empirical evidence has supported this proposition. Three studies in Part II provide empirical tests of gene–environment interactions. In Chapter 8, Avshalom Caspi and his colleagues examine whether the effect of a polymorphism of the monoamine oxidase A (MAOA) gene on measures of antisocial behaviour would be moderated by childhood maltreatment. (MAOA is an enzyme that degrades certain neurotransmitters in the synaptic gap after they have performed their messenger role.) The significance of this study was that it was the first to provide evidence of a gene–environment interaction between a measured gene and a measured environmental factor.

Guang Guo, Michael Roettger and Tianji Cai, in Chapter 9, also tested for gene–environment interactions by examining the interaction between neurotransmitter genes and various modes of social control on the creation of delinquency. In the study described in Chapter 10, Kevin Beaver examined whether the cumulative effects of dopaminergic genes on violent delinquency were moderated by a childhood history of sexual abuse. Taken together, all three studies reveal that the effects of genes on antisocial phenotypes are moderated by exposure to certain environmental conditions.

Gene–Environment Correlations and Criminal Behaviour

During the last twenty years or so, a line of behavioural genetic research has begun to use twin-based methodologies to examine genetic influences on measures of the environment (Plomin and Bergeman, 1991). The results of these studies have once again provided strong empirical support indicating that most factors usually considered purely environmental are modestly influenced by genetic factors. A wide range of studies, using very different samples, has revealed that measures of the family environment, peer relationships, parenting behaviours and religious beliefs are all affected by genetic factors (Kendler and Baker, 2007). At first glance, this might seem a bit odd; after all, how could 'social-environmental measures' be affected by genes? Behavioural geneticists have advanced the logic of gene–environment correlation to explain the underlying mechanisms that can account for how genes influence the environment (Plomin, DeFries and Loehlin, 1977; Scarr and McCartney, 1983).

There are three main types of gene–environment correlations, the first of which is referred to as a passive gene–environment correlation. The concept of passive gene–environment correlation recognizes that parents pass along to their children both a rearing environment and a genotype. Given that both of these elements arise from the same source (that is, parents), they are likely to be correlated with each other. To illustrate, parents who are physically aggressive are likely to pass along a genotype to their child that predisposes them to be aggressive. In addition, the learning environment that they provide to their child, such as frequent exposure

to parental aggression, will also likely facilitate the development of aggressive tendencies in the child.

The second type of gene–environment correlation is an evocative gene–environment correlation, which avers that our genetic dispositions matched with our early experiences bias our actions in certain directions, and that these actions evoke responses from others in our social environments. For example, a child with a difficult temperament may evoke harsh parenting and other forms of negative reaction from teachers and peers. Negative responses evoked from others will serve to exacerbate the child's difficult temperament and drive him or her to seek social environments in which such behaviour is accepted, usually populated by individuals similarly disposed. Evocative gene–environment correlation thus serves to magnify differences among phenotypes – that is, the joint effects of genes and environments accentuate the phenotype beyond which either could produce independently.

The third type of gene–environment correlation is known as an active gene–environment correlation. The concept of active gene–environment correlation suggests that genotypes are instrumental in nudging us into one environment rather than another – that is, people with certain genetically influenced talents choose environments that allow optimal genetic expression of them. Within the range of cultural possibilities and constraints, our genes help to determine what features of the environment will and will not be salient and rewarding to us. Of course, passive and evocative gene–environment correlations ensure that social experiences will also help us to determine the environments we seek. Thus evocative and active gene–environment correlations feed back to one another. Active gene–environment correlation gains momentum as individuals mature and acquire the ability to take greater control of their lives. The effects of genes on forming these environments can be gauged by studies showing that the intelligence, personalities, attitudes and lifestyles of MZ twins are essentially unaffected by whether or not they were reared together. That is, MZ twins reared apart construct their environments about as similarly as they would have had they been reared together and considerably more similarly than DZ twins who were reared together (Plomin, 2005).

Empirical studies exploring the role of gene–environment correlations in relation to various environments have accumulated at a relatively quick pace recently (Kendler and Baker, 2007); however, very few studies have examined this issue as it relates directly to criminology and criminogenic environments. One of the main exceptions to this general rule is a study conducted by Harrington Cleveland, Richard Wiebe and David Rowe (Chapter 11). In this study, the authors analysed a sample of various kinship pairs to estimate genetic, shared and non-shared environmental influences on exposure to drug-using peers. This is a particularly important issue to criminologists because measures of delinquent peers are among the strongest predictors of adolescent delinquency. In general, the influence that peers have on delinquency has been considered mostly a purely social process. The research carried out by Cleveland and associates casts serious doubt on this assumption by showing that contact with delinquent peers is strongly influenced by genetic factors, providing empirical evidence of a gene–environment correlation in exposure to delinquent peers.

Evolutionary Psychology and Crime

Whereas genetics seeks to identify genetic factors that differentiate people, evolutionary psychology seeks to identify factors that make people the same. Because all traits identified with criminal behaviour are heritable, we have to ask why the genes underlying them exist. The genome is the chemical history of accumulated wisdom that has survived millions of years of ruthless natural selection, and genes that currently exist in the gene pool of any species are assumed to be there because they somehow conferred an advantage on ancestral organisms. Genes underlying the traits associated with criminal behaviour have survived across the generations because they are assumed to have served some useful evolutionary purpose. Thus criminologists operating within an evolutionary framework investigate how behaviours we call criminal today may have been adaptive in our evolutionary past. These criminologists draw heavily on Darwin's theory of evolution by natural selection. A theme central to Darwin's theory is that populations continue to expand until they place a strain on the environment. All living organisms thus compete for these scarce environmental resources in which only the 'fittest' members survive (Walsh and Beaver, 2009).

Darwin realized that there is tremendous variation both between and within populations in respect to observable (for example height and weight) and unobservable (for example personality traits, cognitive process) characteristics. Certain of these variants provided some members of a breeding population an advantage over others. For example, in a human non-industrial society being faster and stronger than most other group members translates both into a lower probability of being eaten by a predator and a higher likelihood of catching prey. It would also translate into greater mating opportunities, or reproductive success, which is the biologists' measure of 'fitness'. A greater number of offspring, of course, means that the genes underlying the fitness traits would proliferate in the genes pool. Darwin called this process of genetic retention and elimination natural selection because it is nature (that is, the environment) that 'selects' the genes underlying the traits that increase fitness.

The driving force of natural selection is thus the differential reproductive success of genotypes in a given environment. Genotypes that confer a high fitness advantage in one environment are more likely to be reproduced in future generations. Natural selection is the engine that drives evolution because it continuously forces organisms to change in response to their environments. These changes are referred to as adaptations, and adaptations surface and survive because they promote some type of fitness advantage. Keep in mind that evolution cannot peer into the future to produce optimal adaptations; rather, natural selection works through a mindless algorithmic process of trial and error in which current environmental obstacles force organisms to adapt or die. It must be noted that to claim that something is an adaptation is to make a claim about the past, not the present, and certainly not about the future; what was adaptive in the distant past may be maladaptive (ill-fitted) in current society, which presents new challenges for adaptation.

Evolutionary psychological explanations of human behaviour complement genetic explanations because evolution reveals how specific genes came to be common in a gene pool. But while genetic and evolutionary explanations are very much complementary, they seek to identify the causes of human behaviour by asking very different questions. Evolutionary psychologists explore the potential causes of crime by looking at ultimate-level 'why' questions rather that proximate-level 'how' question. For example, while geneticists

may answer the question of why males are more aggressive and violent than females by invoking different levels of testosterone, evolutionary psychologists would attempt to answer the same question by asking why these different levels exist in the first place – that is, what evolutionary problems did violence and aggression solve for males in the evolutionary past that led to increased selection for higher levels of testosterone for males but not for females?

Although evolutionary psychologists seek to provide ultimate-level explanations, this does not mean that they consider culture and environmental factors unimportant; they simply ask us to remember that 'psychology underlies culture and society, and biological evolution underlies psychology' (Barkow, 1992, p. 635). Gene–culture co-evolution theory maintains that nature (genes) and nurture (cultural learning) constitute a fully integrated reciprocal feedback system. The genome and culture are both information transmission devices; the former laying the foundation (the capacity) for the latter, and the latter then influencing the former (what genetic polymorphisms are useful in this culture at this time, and when and for how long should they be expressed?). The basic idea of gene–culture co-evolution is that if a novel trait or behaviour emerges that happens to be culturally useful, those displaying the trait or behaviour will be culturally advantaged in terms of securing resources and mates, and thus the relevant gene underlying the novel trait or behaviour will be preserved and proliferate in the population gene pool. Thus ultimate-level explanations are meant to augment and add clarity to – not replace – proximate-level explanations.

The first two essays in Part III provide a thorough discussion of evolutionary psychology revealing how evolutionary explanations of crime include a heavy contribution from the environment. Chapter 12, by Lee Ellis and Anthony Walsh, provides a detailed discussion of evolutionary psychology, including explanations of evolutionary concepts that are foreign to most sociologically trained criminologists. The authors also expose the reader to various evolutionary explanations of crime and set forth hypotheses to guide and inform criminologists working from an evolutionary framework. In Chapter 13 Canadian sociologist Augustine Brannigan advances an evolutionary theory of crime. One of the unique features of this essay is how Brannigan grounds this evolutionarily informed theory in two of the more dominant criminological theories: self-control theory and social control theory. Brannigan shows how environmentally oriented theories can be integrated with evolutionary psychology perspectives to create rich theories of criminal and antisocial behaviour.

Reproductive Strategies and Criminal Behaviour

Every evolutionary theory of criminal, delinquent and antisocial behaviour emphasizes reproductive strategies and the behavioural patterns that underlie them (Walsh, 2006). There are two types of reproductive strategies employed by all sexually reproducing organisms: parenting and mating. These strategies are identifiable by quantifying the time and energy devoted to parenting effort versus mating effort. Parenting effort refers to the amount of reproductive effort devoted to rearing offspring, while mating effort refers to the amount of reproductive effort devoted to acquiring sexual partners. Some species, such as oysters, invest all of their reproductive effort in mating and none in parenting, while others, such as *Homo sapiens*, invest a large proportion of their reproductive effort in parenting (although that is differentiated by gender). Variation in reproductive strategies is dependent on a range of evolved traits. Among humans, parenting effort is associated with the traits of empathy,

nurturance, intelligence, conscientiousness and altruism, while mating effort is associated with the traits of deceitfulness, impulsiveness, sensation-seeking and aggression (Rowe, 2002; Walsh, 2006).

Evolutionary criminology is animated greatly by the realization that traits associated with mating effort are the same traits that are also associated with antisocial behaviours, while the traits that are associated with parenting effort are associated with more pro-social behaviours. David Rowe (1996, p. 270) summarized the nexus between mating effort and crime by noting that 'crime can be identified with the behaviors that tend to promote mating effort and noncrime with those that tend to promote parenting effort'. Because humans are born highly dependent on the nurturance of their parents, a high proportion of reproductive effort in *Homo sapiens* is devoted to parenting effort. As with all species there is a high degree of variability in the strategies employed by individuals, ranging from an exclusive focus on mating strategies to an exclusive focus on parenting strategies, with most of us allotting different levels of time and energy to one or the other at different times in our lives. What this necessarily means is that the traits associated with each reproductive strategy are arranged on a continuum and are not either/or categories.

Persons who have very high levels of the traits associated with mating effort, such as high levels of impulsiveness and aggression (which are associated with low levels of serotonin and high levels of testosterone, respectively), are not only likely to shun parenting and focus on mating, but they are also likely to engage in a range of antisocial behaviours. An impressive amount of research has supported this proposition by revealing that persons who focus their resources on mating effort are also likely to be involved in criminal behaviour. To illustrate, Ellis and Walsh (2000) reviewed 51 studies that had examined the association between number of sex partners and criminal behaviour, and found 50 of these studies to be significantly and positive related, and a review of 31 other studies found that age of onset of sexual behaviour was significantly inversely related to criminal behaviour in all 31. A British cohort study found that the most antisocial 10 per cent of males fathered 27 per cent of the children (Jaffee *et al.*, 2003), and anthropological studies reveal striking differences in behaviour between members of cultures that emphasize parenting versus mating strategies. Behaviours considered antisocial in Western societies such as low-level parental care, hypermasculinity, transient bonding and violence are normative in cultures worldwide that emphasize mating effort (Ember and Ember, 1998).

In Chapter 14 Kevin Beaver, John Paul Wright and Anthony Walsh employ a gene-based evolutionary perspective to examine the association between number of sex partners (that is, mating effort) and criminal involvement. They were interested in determining whether the genes that influence mating effort were the same genes that influence antisocial behaviour. The results of their analysis provided empirical evidence consistent with evolutionary theory in that one gene (DAT1) that was associated with an increased number of sex partners was the same gene associated with an increased probability of criminal involvement.

Evolutionary psychology has also been applied to well-known correlates of crime, such as the very strong association between gender and criminal involvement. Everywhere and always, males are much more violent and aggressive than females. The most common evolutionary explanation for gender differences in crime is that females are more likely to employ parenting reproductive strategies while males are more likely to employ mating reproductive strategies. As a result, females are likely to possess a larger proportion of the genes underlying the

traits associated with parenting effort, such as altruism and empathy, than males. Males, in contrast, are likely to possess the traits that underlie mating effort, such as aggressiveness and impulsivity. And, these same traits are known to predict involvement in crime and violence. Chapter 15 by psychologists Anne Campbell, Steven Muncer and Daniel Bibel moves beyond simply describing male–female differences in crime and presents a theoretical explanation for the evolutionary factors associated with female criminal behaviour.

Age is one of the most consistent predictors of criminal involvement across every society ever studied. In general, delinquent involvement emerges around the age of 12, at which time it increases steadily until the late teens or early twenties when it begins a downward trend. By around the age of 30, criminal involvement is virtually non-existent for the majority of the population. This inverted-U shaped association between age and crime is known as the age–crime curve. Although numerous attempts have been made by criminologists to identify the factors that explain the age–crime curve, they have generally failed. In Chapter 16, however, Satoshi Kanazawa and Mary Still show that the age–crime curve can be explained from an evolutionary psychological perspective. Taken together, these essays reveal the potential importance of evolutionary psychology in explaining and understanding two of the most common correlates of criminal and delinquent involvement: gender and age.

Neuroscience and Crime

Part IV comprises essays that explore the connection between the neurosciences and crime. The neurosciences are broadly interested in examining how variation in the anatomy, physiology and chemistry of the brain corresponds to variation in psychological and behavioural phenotypes. Variation in the brain is divided into variation in functioning and variation in the structure. Brain functioning refers to the processes carried out by the brain, such as the activity-level of certain regions of the brain when performing certain tests. Brain structure, in contrast, refers to quantifiable measures of the brain, such as the size, length and volume of particular regions of the brain. Sophisticated brain-imaging techniques, such as magnetic resonance imaging (MRI), functional magnetic resonance imaging (fMRI), positron emission tomography (PET) and single photon emission computed tomography (SPECT) are used to map the structure and function of the brain. Biosocial criminologists then use the information generated from brain-imaging techniques to examine whether variation in the structure and the function of the brain is associated with involvement in antisocial behaviour.

Genetic factors play an integral role in creating variation in the structure and functioning of the brain, with estimates indicating that 50 to 60 per cent of all human genes are involved in the development of the brain. Although the structure and functioning of the brain is under heavy genetic control, the environment is hugely important in the development of the brain; neuroscientists do not argue about '*whether* the environment thoroughly influences brain development, but *how* it does' (Quartz and Sejnowski, 1997, p. 579). Genes carry an immense amount of information about how to build the brain and other factors germane to brain development, but there are simply not enough genes to specify all of the intricacies of the brain. This is where the environment comes into play because if only genes mattered, we would be unable to adapt to environmental challenges and novel situations.

Two developmental processes – experience-expected development and experience-dependent development – have been identified that help to explain the interplay between

genes and the environment in the creation of the brain (Walsh and Beaver, 2009). Experience-expected mechanisms reflect the phylogenic history of the brain and are hard-wired; experience-dependent mechanisms reflect the brain's ontogenic plasticity. That is, all member of a species inherit species-typical brain structures and functions from a common pool of genetic material, but individuals will vary in brain functioning as their genes interact with the environments they encounter (Depue and Collins, 1999; Gunnar and Quevedo, 2007). Experience-expected processes have evolved as neural readiness during certain 'critical' developmental periods to incorporate environmental information that is vital to an organism and ubiquitous in its environment. Certain processes such as sight, speech, depth perception, affectionate bonds, mobility and sexual maturation are vital, and natural selection has provided for mechanisms (adaptations) designed to take advantage of experiences occurring naturally within the normal range of human environments. Pre-experiential brain organization frames or orients our experiences so that we will respond consistently and stereotypically to vital stimuli.

Experience-dependent development, on the other hand, draws attention to variation in neural mechanisms accounted for by different individual environmental experiences. Variation in physical, social and cultural factors creates variation in the functioning of the brain: 'experience-dependent processes are central to understanding personality as a dynamic developmental construct that involves the collaboration of genetic and environmental influences across the lifespan' (Depue and Collins, 1999, p. 507). In a nutshell, what the experience-dependent process actually means is that neural connections are continuously built, retained or eliminated, depending on input patterns from the environment and how the organism perceives and responds to them.

To understand how the functioning and structure of the brain could be related to crime and violence, it is important to be familiar with the areas of the brain that are thought to be tied to antisocial behaviours. In Chapter 17 James Fallon presents a detailed overview of the anatomy of the brain as well as an excellent discussion of the regions of the brain – and what they are responsible for doing – that have been linked to psychopathy and other forms of antisocial behaviour. The information contained in this essay provides the basic material needed to understand the specific ways in which the brain may contribute to violence, aggression and criminal involvement.

As Fallon notes, one area of the brain that has consistently been found to be associated with violence and crime is the prefrontal cortex. The prefrontal cortex, which is located in the frontal lobes directly behind the forehead, is subdivided into three different areas. The first area of the prefrontal cortex is known as the dorsolateral prefrontal cortex (DLPFC) and is central to behavioural regulation, information processing and the formation of memories. The second region of the prefrontal cortex is the medial prefrontal cortex (MPFC). The MPFC is involved in tasks and behaviours that demand a significant amount of attention and concentration. The last region of the prefrontal cortex is the orbitofrontal cortex (OFC), which is involved in goal-oriented actions, decision-making algorithms, judgement and the regulation of emotions. Although all three regions of the prefrontal cortex have been linked to behavioural problems, the OFC is the region that is thought to be the most strongly related to antisocial behaviours. The importance of the OFC to crime is highlighted in the next two essays, which present theoretical perspectives centred on the OFC.

In Chapter 18 R.J.R. Blair examines the way in which the OFC contributes to two types of aggression: reactive aggression and instrumental aggression. Broadly speaking, reactive

aggression refers to aggression that is exhibited in response to an environmental trigger, while instrumental aggression refers to aggression that is employed to achieve some potential goal. Blair presents a great deal of evidence indicating that the OFC is strongly associated with reactive aggression, but not necessarily instrumental aggression. The examples and discussions contained in Blair's essay will provide a valuable tool to criminologists seeking to map out the complex ways in which the brain – especially the OFC – contributes to antisocial phenotypes.

Chapter 19 advances a theoretical framework that explains adolescent risk-taking. Laurence Steinberg places the brain at the centre of his perspective and presents evidence showing that risk-taking behaviours across the life course can be explained by developmental changes that occur inside the brain. His basic argument is that increases in risk-taking between childhood and adolescence are linked to changes in regions of the brain that control behaviour, emotion and judgement. As with all biosocial perspectives, however, Steinberg does not believe that these neuronal changes work in isolation to affect risk-taking; rather, he argues that the adolescent's brain is particularly susceptible to the power of peer socialization. The drop in risk-taking in adulthood, according to Steinberg, is also explainable through developmental changes to the brain where areas of the brain that are involved in self-regulation and cognitive control mature. Steinberg's perspective shows the power that biosocial theories can have in explaining some of the 'brute facts' of crime, such as the well-documented, but poorly understood, age–crime curve.

The last two essays in the volume – Chapters 20 and 21, both written by Adrian Raine and his colleagues – employ brain-imaging techniques to examine whether variation in the brain is associated with severe violence. The first study used PET scans to analyse the brains of convicted murderers and controls matched for age and sex. The brain-imaging analysis detected a number of functional and structural abnormalities in the brains of the murderers, including reduced activity in the prefrontal cortex and asymmetry of the amygdala (an area of the brain associated with emotional memories and fear processing). Raine and his colleagues followed up this study with another that also used PET scans. This time, however, they examined brain functioning in predatory murderers (that is, murderers who seek out their victims and murder in cold blood), affective murderers (that is, murderers who murder in an act of rage) and a control group. The results reported by Raine *et al*. are most certainly interesting in that they found some differences in brain functioning, especially in the prefrontal cortex, among these three groups. Together, the results of these studies provide solid evidence indicating that various regions of the brain – especially the prefrontal cortex – are associated with a range of antisocial phenotypes.

Summary and Conclusion

So what is biosocial criminology and what is its agenda? Its hope and agenda is no different from that of Karl Marx, who wrote more than 150 years ago that 'Natural science will, in time, subsume under itself the science of man, just as the science of man will subsume under itself natural science: there will be one science' (1978, p. 91). Rather than viewing biology as a threat, biosocial criminologists welcome it as providing an opportunity to collaborate with a very robust ally that has a bounty of treasures to offer. With Karl Marx, we maintain that the social sciences need these offerings; just as the history of the physical and natural sciences has

demonstrated, the cross-fertilization of concepts, methods and theories breeds hybrid vigour into the younger science.

The essays in this volume show that criminologists have nothing to fear from genes; there are far too few of them to exercise control over our behaviour. Complex organisms living in complex environments cannot possibly be hard-wired for every potential situation they could encounter. We could never be pre-programmed to respond to all the possibilities in fixed, undeviating ways. Genes simply provide humans with some very general rules, such as 'avoid snarling creatures', 'favour close kin', 'enjoy sex', 'cooperate with others', 'fear heights' or, even more generally, 'seek pleasure and avoid pain', and then leave the specifics to the judgement of the whole organism (Walsh, 2009).

Nor should criminologists fear the intrusion of evolutionary biology. We are all descended from ancestors who successfully overcame the adaptive problems of all living things – how to survive and reproduce. The behavioural traits that aided in solving these problems are still with us today and, as the essays in this volume show, some of them can and are used for purposes other than those for which they were designed. These broad behavioural categories have to be identified and explored in detail, and that is why we need a common framework from which to proceed. For this reason, a growing number of leading social/behavioural scientists are 'gaining enthusiasm for a Darwinian framework, which has the potential to tie together the forest of hypotheses about human behavior now out there' (de Waal, 2002, p. 187). To be sure, evolutionarily inclined criminologists emphasize the negative side of human nature to the neglect of its many positives. They are aware that evolution in social species is more about cooperation than conflict, but a criminologist's stock in trade is vice, not virtue. Cooperation confers benefits on all cooperators, identifying them as reliable, altruistic and trustworthy, which are traits conspicuously absent in most criminals.

Regardless of whether a stimulus comes from our genes or our environment, all stimuli have to be channelled through the brain before a response is initiated. As the executor of our behaviour, we cannot afford to view the brain as a mysterious and foreboding 'black box' that can be safely ignored. We need not be concerned with the arcane minutia of neuroscience (nor the minutia of genetics or evolutionary biology), but we should learn its basic language so that we may understand the criminological relevance of its research findings. We may find that by doing so we will fill in many theoretical blanks and prevent criminologists from inventing improbable scenarios to account for the origins of criminogenic risk factors such as self-control, fearlessness, intelligence, aggression, status-seeking and so forth. Again, this does not lead to a dismissal of environmental factors related to these variables because, as we have seen, environmental experiences are *physically* captured in the brain's circuitry.

Moving from the nineteenth to the twenty-first century, we have another 'grand old man' of social science – Francis T. Cullen – also expressing the hope that criminology will integrate with the biological sciences. Describing himself as a proud member of the sociological paradigm, Cullen is nevertheless 'persuaded that sociological criminology has exhausted itself as a guide for the future study of the origins of crime. It is a paradigm for the previous century, not the current one' (2009, p. xvi). He goes on to identify the biosocial paradigm – 'a broader and more powerful paradigm' (2009, p. xvii) – as the paradigm that will take the place of sociology for twenty-first-century criminology. We hope that this volume contributes in a small way to this paradigm shift.

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BIOLOGICAL PERSPECTIVES IN CRIMINOLOGY*

DIANA H. FISHBEIN
University of Baltimore

For several decades, mainstream criminology has been dominated by sociological and political perspectives. Although findings from these fields must not be discarded or underplayed, considered alone, they do not offer a complete assessment of the contributions to criminal behavior. Data currently being generated from numerous behavioral sciences, such as behavioral genetics, physiological psychology, psychopharmacology, and endocrinology, indicate that biological factors play an equally significant role in the development of antisocial behavior and should be considered accordingly. Incorporation of the theoretical parameters and findings of these behavioral sciences into a criminological framework would yield valuable information regarding processes underlying antisocial behavior. Such a multidisciplinary approach is likely to enhance capabilities to predict, prevent, and manage antisocial behavior. Theoretical parameters, methodological issues, selected research findings, potential applications, and precautions are discussed.

Wilson and Herrnstein (1985) recently published a massive evaluation of the implications of biological data for topics of interest to criminologists. Their message is that insufficient consideration has been given to biological and social interactions in criminological studies. Consistent observations that a small percentage of offenders are responsible for a preponderance of serious crime (Hamparin et al., 1978; Moffitt et al., 1989; Wolfgang, 1972) suggest that particular forces produce antisocial behavior in particular individuals. Further, much research shows that violent criminals have an early history of crime and aggression (Loeber and Dishion, 1983; Moffitt et al., 1989). The possibility that biological conditions may play a role in the development of antisocial and criminal behavior is accentuated by these reports and has spurred a search for biological markers in "vulnerable" subgroups (Mednick et al., 1987).

In the past, theories of the biological aspects of criminal behavior were marked by a general lack of knowledge regarding the human brain and by serious methodological shortcomings (see, e.g., Glueck and Glueck, 1956; Goddard, 1921; Hooten, 1939; Jacobs et al., 1965; Lombroso, 1918; Sheldon, 1949). Indeed, "biological criminology" was eventually discredited because

* I would like to express my appreciation for the editorial comments of Drs. C. Ray Jeffery, Derral Cheatwood, and Kathleen Block.

its findings were largely unscientific, simplistic, and unicausal. Biological factors were globally rejected due to the inability of theorists to posit a rational explanation for the development of criminal behavior.

More recently, biological aspects of criminal behavior have been investigated by numerous behavioral scientists employing a multidisciplinary approach that promises to enhance substantially the rigor of the findings. Scientists in such fields as genetics, biochemistry, endocrinology, neuroscience, immunology, and psychophysiology have been intensively studying aspects of human behavior that are relevant to the criminologist and the criminal justice practitioner. Due to the highly technical and field-specific language of much of this research, findings generated from these works are not usually included in the literature reviews of criminologists. The relative lack of interdisciplinary communication has resulted in a lack of awareness of data pertinent to the study of crime and criminal behavior. This paper is a small step toward filling that gap.

The primary purpose of this paper is to present an overview of biological perspectives on the study of crime. Once acquainted with the parameters and findings of biological research, criminologists may begin to incorporate reliable biological aspects of criminal behavior into their theoretical and applied frameworks. Specific findings in biology are presented for criminologists to consider. Although the paper provides only an initial, condensed introduction to the vast amount of work accomplished in the behavioral sciences, it may help develop a sound, scientific, and pragmatic framework for future criminological research with a multidisciplinary orientation.

THEORETICAL AND METHODOLOGICAL PARAMETERS

Several critical issues must be addressed in order to (1) establish the relevancy of biology to the study of crime, (2) develop the groundwork for including biological data in criminological theories, (3) design research projects using compatible measurement instruments, data sets, and statistical techniques, and (4) determine the boundaries of practical applications of biological findings. These four requirements for multidisciplinary investigation in criminology are contingent on the assumptions and paradigm of the researcher, which have yet to be set forth adequately in the criminological literature. Pertinent issues include nature versus nurture, free will versus determinism, identifying relevant behavioral disorders and subject populations, assumptions and conceptual framework, and finally, methodological considerations. The discussion of these issues that follows may be opposed or modified by other criminologists with a biological orientation. This discussion is not intended as the last word, but rather as one of the first.

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NATURE OR NURTURE?

The first issue that must be addressed before the parameters of biological research in criminology can be established is the age-old question of whether human behavior is a product of nature or nurture. Theoreticians of the past generally espoused one or the other viewpoint. Those who claim that nature contributes predominantly to an individual's behavior have been affiliated in the past with conservative political ideologies and were known as "hereditarians." In this circle, behavior was primarily attributed to inherited predispositions, and genetic influences were considered responsible for most of the variance in complex human behaviors.

The argument that nurture is the impetus for behavior was advocated by the "environmentalists," who were generally associated with a liberal ideology. Watson's (1925) interpretation of John Locke's *tabula rasa* (blank slate), for example, maintained that humans are born without predispositions to behave in any predetermined or predictable manner. Environmental inputs were considered primarily responsible for the final behavioral product, and manipulations of external inputs were thought to modify behavior.

These opposing views are reflected in past political and social movements, such as *radical behaviorism* and *social Darwinism*, many of which have had devastating social and scientific consequences. The concept of *predatory ethics*, couched in the possibility of the state's punitive sanctioning of "unacceptable" or merely predicted future behaviors, eventually contributed to a complete rejection of biological perspectives by many scientists and their sponsors. The threat of "control and oppression by science" was realized and feared.

Few behavioral scientists today adhere to either of these extreme views. A consensus has been emerging over the past 10 to 15 years that the "truth" lies somewhere in between—a "nature plus nurture" perspective (see Plomin, 1989). Although the nurture perspective has dominated fields such as criminology for the past few decades, substantial biological findings can no longer be ignored. Several studies on alcoholism, temperament, criminality, depression, and mental illness have established a solid role for genetic and biological influences (selected recent examples are detailed below). Even though behavioral scientists have yet to determine precisely the separate, relative contributions of biology and social learning to behavior, their findings are particularly relevant to the criminologist, who should play an instrumental role in their evaluation given the potential impact on policy.

Evidence for an interaction between nature and nurture comes from both animal and clinical studies, which demonstrates the strength and importance of the dynamic link between biological and acquired traits. One example of this interaction is that aggressive behavior in monkeys can be elicited by stimulating certain areas of the brain with implanted intracerebral electrodes (see

Carlson, 1977:442–449). The final behavioral result depends on the hierarchical structure of the monkey colony. Dominant monkeys will exhibit aggressive behavior with electrical stimulation of the brain in the presence of a submissive monkey. The same monkeys will suppress aggressive behavior, on the other hand, if another dominant monkey is present. An example of this interaction in humans is illustrated by recent reports that gender differences in cognitive ability are decreasing (see Geary, 1989). Cognition, however, is fundamentally influenced by neural processes that operate during an individual's development (ontogeny). In an effort to explain changing trends in a seemingly immutable biological process, researchers are discovering that cultural and experiential conditions directly influence the developing pattern of cognitive abilities. For example, activity patterns (e.g., frequency of rough and tumble play) may alter cognitive ability (e.g., spatial skills) by modifying processes of brain development.

These illustrations remind us that as evidence for a substantial genetic influence grows we must be cautious not to replace environmental explanations with biological deterministic views. Instead, a more accommodating, balanced approach will carry more empirical weight.

FREE WILL OR DETERMINISM?

The acceptance of biological explanations for human behavior has been thought by many to preclude the possibility of free will. This fundamental fear has resulted in a pervasive rejection of biological contributions to behavior. Although some behavioral scientists are deterministic in their views, attributing behavior to everything from socioeconomic conditions to neurochemical events, most individuals prefer to credit their own free will for their behavior. A compromise reflecting a more accurate position on the forces behind human behavior is widely accepted, however—the theory of "conditional free will" (see Denno, 1988, for discussion of "degree determinism," a related view).

In probabilistic or stochastic theories, numerous causes or alternatives are presented to explain an effect. Each cause has a certain probability of resulting in that outcome, in some cases a measurable probability. Because it is rarely the case that an effect can be associated with only one cause, some dynamic interaction of causes, working in concert, is frequently responsible for the final result. In the assessment of human behavior, a most complex phenomenon, it is particularly difficult to separate those causes to assess their relative contributions.

In accordance with probability theory, social human behavior is contingent on a countless number of possible decisions from among which the individual may choose. Not all of those decisions are feasible, however, nor are the resources available that are required to act on them. Choosing a course of

action, therefore, is limited by preset boundaries, which narrows the range of possibilities substantially. Decision-limiting factors include current circumstances and opportunities, learning experiences, physiological abilities, and genetic predispositions. Each one of these conditions collaborates internally (physically) and externally (environmentally) to produce a final action. The behavioral result is thus restricted to options available within these guidelines, yet it is "indeterminable" and cannot be precisely predicted. Stable individuals generally behave with some degree of expectability, however. In other words, certain patterns of behavior are a common individual characteristic, and some patterns are more probable than others in a given situation in a given individual.

The principle of conditional free will does not demand a deterministic view of human behavior. Rather, it postulates that individuals choose a course of action within a preset, yet to some degree changeable, range of possibilities and that, assuming the conditions are suitable for rational thought, we are accountable for our actions. Given "rational" thought processes, calculation of risks versus the benefits, and the ability to judge the realities that exist, the result is likely to be an adaptive response, that is, the behavior will be beneficial for the individual and the surrounding environment.

This theory of conditional free will predicts that if one or more conditions to which the individual is exposed are disturbed or irregular, the individual is more likely to choose a disturbed or irregular course of action. Thus, the risk of such a response increases as a function of the number of deleterious conditions. For example, a child with a learning disability may function well in society. With the addition of family instability, lack of appropriate educational programs, and a delinquent peer group, however, the learning-disabled child may be more prone to maladaptive behavior, which may, in turn, result in actions society has defined as criminal. The child's range of possible decisions has, in other words, been altered.

IDENTIFYING BEHAVIORS AND POPULATIONS FOR STUDY

Definitional issues are hotly debated among criminologists as a result of the growing recognition that not all "illegal" behaviors are dysfunctional or maladaptive and not all "legitimate" behaviors are moral, acceptable, or adaptive. In attempting to develop a framework for including biological perspectives in criminology, one must first identify behaviors of interest and appropriate subject populations.

The term *criminality* includes behaviors that do not necessarily offend all members of society, such as certain so-called victimless acts, and it excludes behaviors that may be antisocial or illegal but that are not detected by the criminal justice system. *Maladaptivity* includes antisocial behaviors that are

costly to citizens and society overall. Such behaviors do not necessarily violate legal norms or come to official attention, however. Individuals who display maladaptive behavior do have a high probability of being labeled as delinquent or criminal, but being so labeled is not a sufficient criterion to be identified as maladaptive. For example, schizophrenics have abnormalities in brain structure and function that cause them to behavior maladaptively; their behavior is poorly regulated, detrimental to their own well-being, and considered "deviant" by others. Nevertheless, they rarely manifest criminal tendencies. In the same vein, individuals who have been diagnosed as having antisocial personality disorder (American Psychiatric Association, 1987), a condition associated with several aberrant physiological traits (see Hare and Schalling, 1978; Howard, 1986; Yeudall et al., 1985), are more likely to violate legal norms given conducive social circumstances. Yet, there are numerous examples of individuals with antisocial personality disorder who find legal, albeit not always ethical, avenues for channeling their behavioral tendencies (e.g., some of those involved in competitive sports, high-risk activities, corporate life, and politics).

Criminal behavior is not exclusively maladaptive or dysfunctional behavior; thus, biological theories are differentially relevant to various forms of criminality. Biological findings in behavioral research are of particular interest for the study and management of maladaptive behaviors, both criminal and undetected behaviors that are detrimental to individuals so affected or their milieu. This paper focuses on maladaptive behaviors that may place an individual at risk for criminal stigmatization, in particular violent criminal behavior.

CONCEPTUAL FRAMEWORK

It is essential in this paper to provide a conceptual framework for eventually relating and integrating the concepts fundamental to criminology and behavioral biology. This task requires a model describing the underlying assumptions about human behavior generally, a theory of the etiological development of maladaptive behaviors specifically, and practical implications for the criminal justice system. Most important, this model of behavior must accommodate well-established theories in the social, psychological, and biological sciences. To this end, this section discusses the importance of the learning process, firmly entrenched in the theories of all three sciences, for the development of human behavior generally and maladaptive behavior specifically.

Individuals are not inherently criminal, nor do they suddenly become homicidal maniacs (except under unusual circumstances). Antisocial behavior has many precursors.[1] Manifestations of a problem are frequently

1. Antisocial children have a high incidence of adjustment problems, for example,

observed in childhood when innate tendencies toward antisocial behavior or other risk factors are compounded by suboptimal environmental and social conditions (Denno, 1988; Lewis et al., 1979, 1985; Mednick et al., 1984). These early seeds of maladaptive behavior are commonly ignored, inappropriately treated, or not recognized as complications that warrant intervention. In such cases, the severity of the condition and resultant behaviors are well advanced by adolescence and adulthood. According to this "developmental course" model of human behavior, criminal behavior is virtually always secondary to an underlying problem(s), as illustrated in Figure 1.

One straightforward example of this process, which pervades the criminological literature, is the link between IQ or learning disabilities and delinquent/criminal behavior.[2] Children with conduct disorders tend to have lower IQ scores than nondeviant controls (Huesmann et al., 1984; Kellam et al., 1975; Lewis et al., 1981; Robins, 1966). Several investigators (Huesmann et al., 1984; Kellam et al., 1975; Olweus, 1979; Richman et al., 1982) have reported that an antecedent factor(s) contributes to both difficulties independently. Probable conditions that may antedate both low IQ and conduct disorder are parental psychopathology, temperamental disturbances, neurological problems, genetic susceptibilities, and disadvantageous environmental influences (Shonfeld et al., 1988). With a learning-disabled or conduct-disordered child, the existence of one or more of these deleterious conditions will increase the likelihood of further adjustment problems. Over time, behavioral difficulties become compounded and, to some extent, reinforced once the child has established mechanisms to protect himself or herself and cope with his or her liabilities. Thus, maladaptive behavior is a function of a cumulative, developmental process.

Although low IQ or a learning disability is not inherently criminogenic, in the absence of proper intervention the child may become frustrated attempting to pursue mainstream goals without the skills to achieve them. Kandel et al. (1988) demonstrated that juveniles with high IQ who were otherwise at high risk for criminal involvement due to their family environments resisted serious antisocial behavior. The researchers stated that their results could be interpreted according to Hirschi's (1969) social control theory. Specifically, students with a high IQ find school more rewarding and, consequently, bond more strongly to the conventional social order. Parents and school systems that are ill equipped to deal with a child suffering from a learning disability, on the other hand, may indirectly contribute to delinquency by removing the child from the classroom, thereby alienating him or her from friends and

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low academic achievement, temper tantrums, conduct disorders, and negative attitudes (see Patterson et al., 1989, for a summary review).

2. See Critchley (1968), Hirschi and Hindelang (1977), McGee et al. (1986), McManus et al. (1985), Perlmutter (1987), Poremba (1975), Robins (1966), Shonfeld et al. (1988), Wolff et al. (1982).

inculcating the belief that the child is "different," possibly even inadequate. Self-esteem is likely to decline dramatically, and the child may learn that there are rewards to be gained from interacting with others who experience similar frustrations. Thus, the child's behavior elicits a negative response from his or her environment, which leads to further reactions from the child (see Patterson et al., 1989). Consequently, the cycle of negatively interacting forces continues and the risk of becoming delinquent and eventually criminal is heightened.

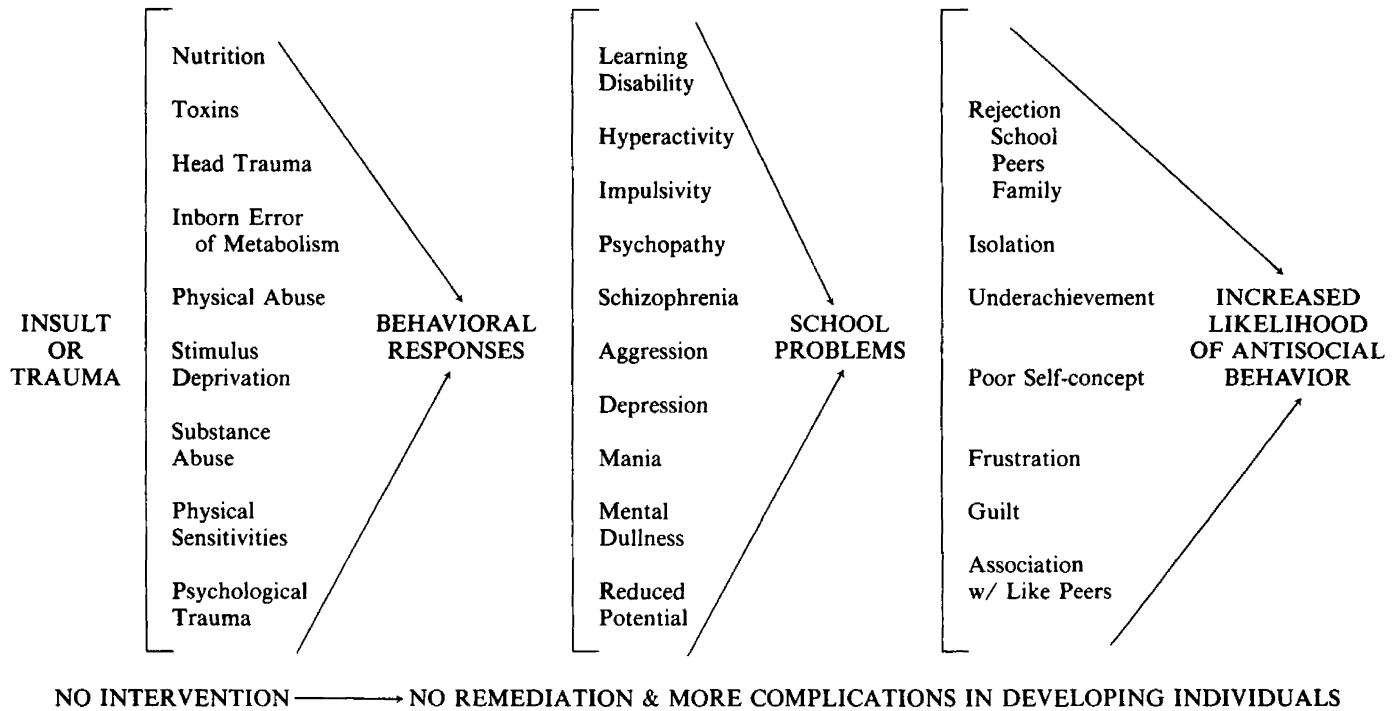
Once the individual attracts the attention of the criminal justice system, the problem is already significantly compounded and difficult to treat, and the costs to society are exorbitant. Evidence for the existence of a developmental phenomenon in antisocial behavior highlights the dire need for early detection and intervention. The earlier the intervention, the more favorable the outcome (Kadzin, 1987).

The learning process as it contributes to behavior cannot be underestimated in this model because, fundamentally, both biological and social behavior are learned. Biological traits and proclivities are not stationary characteristics; they are reinforced or, in some cases, altered through social learning processes. The tendency toward shyness or introversion, for example, is thought to be a stable biological and possibly heritable behavioral quality (see Kagan et al., 1988; Plomin and Daniels, 1986). Kagan et al. (1988) found that children who were extremely shy at the age of 1.5 to 2.5 years continued to be shy and restrained at the age of 7. The children who had moderate levels of shyness, however, did not necessarily retain that trait as they aged. Such temperamental traits may be reinforced by external rewards or expectations or may, on the other hand, be overcome by modeling. Thus, the actualization and longevity of this trait depend on environmental experiences or stressors, including hospitalization or family discord.

Humans are equipped with the innate biological capacity to learn as a product of their genetic blueprint, which is physically expressed in the structure of the brain. When an individual is exposed to a stimulus from the internal (biological) or external (social) environment, permanent changes occur in the neural structure and biochemical function of the brain. This process is referred to as "memory," experiences coded and stored for retrieval in the form of chemical transformations.

Bodily functions involved in memory are multifaceted. Sensation and perception are activities of stimuli reception. Attention and arousal prepare the individual to receive stimuli and react to them selectively. Motivational processes operate so that the individual attends to and later retrieves information. And motor systems permit a response to a memory or experience. When stimuli are received and remembered, all future behaviors are modified, and perception will be subsequently altered. Thus, humans interrelate current experiences with information previously learned, and the future response

FIGURE 1.
DEVELOPMENTAL COURSE MODEL
(THE DEVELOPMENTAL STAGES OF MALADAPTIVE BEHAVIOR)



to an equivalent stimulus may be different. The integrity of each of the above activities determines whether the learning experience will result in accurately encoded memories to produce an appropriate behavioral response.

The learning process of comparing new information with memories to produce a response frequently results in "behavioral conditioning." There is an innate foundation for learning in our biological structure that sets contingencies for behavioral conditioning in an individual, consistent with the premise of conditional free will. Consequently, behavioral sequences are neither programmed nor innate; they are acquired. The two forms of behavioral conditioning, classical and instrumental, both directly involve biological mechanisms. Classical conditioning refers to the response elicited by a neutral stimulus that has been associated with the acquisition of a reward or the avoidance of harm; for example, a white laboratory coat is associated with food and elicits salivation or viewing drug paraphernalia elicits craving for a drug.

When an individual is instrumental in causing a stimulus to occur, operant or instrumental conditioning is at work. The stimulus being elicited either satiates a drive or permits one to avoid a noxious result. For example, if we learn that stealing results in a reward, the behavior will continue. On the other hand, if we are consistently punished for such behavior, we are unlikely to repeat the action. Thus, both forms of conditioning revolve around the same contingencies (biological dictates to avoid pain and seek pleasure, known as hedonism), which function to reinforce our behavior.

Certain behaviors are reinforced when the following conditions exist: (1) the behavior and the stimulus occur together in time and space (continuity), (2) repetition of the association strengthens the conditioned response, (3) the result either evokes pleasure or relieves pain, and (4) there is no interference, as in the form of new experiences, to weaken or extinguish the response. The concept of deterrence is founded on these principles.[3]

In general, the criminal justice system relies on the association made between specific, in this case illegal, behaviors and the application of a painful or punitive sanction, which generally involves the removal of certain freedoms and exposure to unpleasant living conditions. The painful stimulus must be temporally associated with the behavior, consistently applied, and intense enough to prevent further such behaviors. According to the fourth condition listed above, the individual must not learn that the intrinsic reward

3. Moffitt (1983) provides an excellent overview of the learning process in the suppression of punished behaviors as dictated by external and internal contingencies, e.g., cognitive abilities of the individual. Although Moffitt appropriately cautions against the uncritical application of the experimental model of punishment (procedures to manipulate behavior in a laboratory setting) to the process of punishing juvenile offenders, she discusses how the data may be used in constructing more effective deterrence programs.

properties of the behavior are greater or more consistent than the punishment. And finally, opportunities for preferred modes of behavior must be available. Due to the prevalence of low clearance rates, trial delays, inconsistently applied dispositions, legal loopholes, the learning of improper reward and punishment contingencies, and a lack of available legitimate opportunities, the criminal justice system and society at large have been unable to meet the criteria set above for deterrence and prevention.

The experience of a painful consequence being associated with a behavior is encoded into memory, and when we calculate the consequences of performing that behavior in the future we are deterred by the possible negative response. The impetus for such behavioral change resides in our nervous system. We feel anxiety when the threat of a negative repercussion exists because of the learned association between the behavior and its likely consequence. Subjective feelings of anxiety are a result of automatic nervous system responses (a portion of the nervous system that regulates functions not under our conscious control), such as increased heart rate, blood pressure, and hormone release. Thus, the brain initiates a release of hormones that stimulates a subjective feeling of stress whenever we contemplate a behavior that we have been effectively conditioned to avoid. Individuals with a properly functioning nervous system are quite effectively conditioned to avoid stressful situations given the learned contingencies discussed above. Most of us, for example, would experience psychological and physical discomfort at the thought of picking a pocket or burglarizing a convenience store. Thus, we make a rational choice based on a calculation of costs and benefits and, in this case, deterrence is most likely achieved.

The learning and conditioning of behavior occur differentially among individuals given their neurological status. For example, psychopaths are relatively unemotional, impulsive, immature, thrill-seeking, and "unconditionable" (Cleckley, 1964; Moffitt, 1983; Quay, 1965; Zuckerman, 1983). They have also been characterized as having low levels of perceptible anxiety and physiological responses during stressful events (Hare and Schalling, 1978; House and Milligan, 1976; Syndulko et al., 1975; Venables, 1987; Yeudall et al., 1985). Theoretically, psychopaths do not sufficiently experience the discomfort of anxiety associated with a proscribed behavior because they have a hypoaroused automatic nervous system, and thus, they are not easily conditioned or deterred (Hare and Schalling, 1978; Lykken, 1957). They make a rational choice based on the calculation that the benefits of the act (e.g., monetary gain) outweigh the costs (e.g., anxiety and detection). Accordingly, one would expect that psychopaths encountered by the criminal justice system would be resistant to most deterrence programs.

Rewards and punishments influence behavior directly through brain mechanisms. Centers responsible for pain and pleasure are located in a section of the brain known as the limbic system. Not surprisingly, memories are

encoded, stored, and retrieved in this same system. Direct electrical stimulation of certain areas within the limbic system (electrical stimulation of the brain, ESB) is inherently reinforcing, even in the absence of a biological or social drive (Olds and Milner, 1954). An animal quickly learns to perform for ESB due to its drive-inducing and intensely pleasurable effect. In humans, these areas are naturally stimulated when a behavior results in increases in specific neurotransmitters and peptides[4] responsible for either pleasure (i.e., dopamine) or the reduction of pain (i.e., serotonin or beta-endorphins). In large part, which chemicals are released and in which areas depend on both biological and social learning contingencies.[5]

This pain and pleasure mechanism is simply illustrated by the use of cocaine, which directly stimulates the release of dopamine in structures of the limbic system responsible for pleasure (Wise, 1984:15–33). The user quickly learns that cocaine is biologically rewarding, and, along with other reinforcing social circumstances associated with its use, he or she will be more likely to crave and reuse the drug. This is an example of both classical and instrumental conditioning. Other, more complicated, processes involving social learning or conditioning are also involved in the activation of pain and pleasure centers in the limbic system.

Imbalances of the limbic system may alter the proper stimulation of pain and pleasure centers. In schizophrenia, for example, the individual has disturbances in the ability to associate behaviors with a pleasurable outcome and behavior seemingly lacks purpose. It is believed that damage to neural reward structures has occurred (Stein and Wise, 1973). There is also evidence that some psychopaths experience intense pleasure from thrill-seeking or risk-taking activities and have a high pain threshold (Blackburn, 1978). Behaviors that involve an element of danger are not only exciting to these individuals, but they may be addictive in the conventional sense; they produce feelings of euphoria, and the participant may experience discomfort when unable to engage in such activities (Quay, 1965). The possibility that psychopaths have a disturbance in pain and pleasure centers is consistent with studies presented above showing that they have low levels of anxiety and are relatively "unconditionable." There is a large literature on the proneness of these individuals to become involved in delinquent and criminal activities (see Wilson and Herrnstein, 1985), again due to biological traits that are reinforced through social learning.

4. Neurotransmitters and neuropeptides are chemical messengers in the brain that enable brain cells to communicate with each other and other structures.

5. See Gove and Wilmoth, in press, for a discussion of neurological processes that reinforce behavior. The authors suggest that risky and dangerous criminal behaviors stimulate neurological systems that act as positive reinforcers for continuing those forms of dangerous or criminal behaviors. A learning theory of behavior based on biological reward systems is presented.

In sum, social behavior is learned through the principles of conditioning, which are founded on biological and genetic dictates in accord with stimulus-response relationships. Social rewards remain secondary to biological rewards; our desire for money is social, but it is secondary to being a means for obtaining food and shelter. Thus, social behavior satisfies biological needs and drives by providing adaptive mechanisms for reproduction, mating, rearing, defense, and numerous other biological functions. Even though these strategies are fundamentally biological, how we behave to satisfy them relies heavily on learning.

MEASUREMENT AND METHODOLOGICAL ISSUES

Research findings from various behavioral sciences that are relevant to the criminologist can be evaluated in the context of the parameters described above. The next section discusses selected studies that may have bearing on criminological research. A summary critique accompanies discussion of the studies. As a prelude to the discussion, this section examines some of the weaknesses common to such studies.

First, studies of incarcerated populations present obvious problems regarding the generalizability of findings in that any observed effect or correlation may be due to the effects of institutionalization rather than to the variable(s) of interest. Many studies that used institutionalized offenders as subjects did not attempt to measure or control for prison conditions and influences. Also, prisoners are a selective group, and thus their study does not include individuals outside that population with the trait of interest.

Second, many forms of bias in selecting subjects are evident in some studies. For example, several studies focus on criminal offenders and ignore pervasive illegal behaviors in undetected samples. There is a strong possibility that apprehended or incarcerated subjects differ from those who avoid detection in terms of their characteristics and the impact of criminal justice procedures.

Third, the use of control subjects is frequently neglected or inappropriate controls are examined. Unmatched controls or subjects with psychopathology (e.g., schizophrenics) are used all too often as comparison subjects.

Fourth, widely divergent conceptual and methodological principles are, at times, applied across studies, which makes it difficult to compare and replicate findings. Concepts such as psychopathy, antisocial personality, aggression, criminal behavior, and so on, are inconsistently defined and measured. Also, biological parameters are not uniformly identified, for example, electroencephalographic studies employ different measures of brain activity. Measurement instruments differ among studies and interpretations of findings are variable.

Fifth, several points of caution are particularly relevant to interpretation of

studies of psychopathic subjects. The widespread use of self-report and retrospective data is problematic generally, but additional problems arise when these data sources are used to examine offenders, a population notorious for falsifying records. Psychopaths, who are depicted as crafty deceivers, offer especially unreliable data. Yet, self-report measures are frequently used to select and categorize subjects. Not all criminals are psychopaths and vice versa. Moreover, psychological, behavioral, and physiological traits characterizing psychopathy occur along a continuum; psychopathy is not a binary phenomenon. Thus, both personality traits and actual behaviors must be carefully assessed before assigning subjects to groups. Last, the terminology used to describe individuals exhibiting psychopathic behavior is often inexact, confusing, and inconsistent (Blackburn, 1988). The literature suggests that psychopaths are not a homogeneous group (Eysenck, 1977; Hare and Schalling, 1978; Raine, 1988). At least two types of psychopaths have been identified that may be more or less prone to criminal activity: primary psychopaths, who are relatively unemotional, and secondary psychopaths, who have high levels of trait anxiety (Blackburn, 1986; Lykken, 1957). It is to be expected that psychopathy with and without anxiety will be characterized by quite distinct physiological generators and measurable features. Accordingly, reports of psychobiological differences between psychopaths and "normals" have disagreed depending on the definitions and selection criteria used (Devonshire et al., 1988).

Finally, of immediate importance, the majority of so-called multidisciplinary studies have examined only a few variables in isolation, without accounting for interactive effects between biological and socioenvironmental conditions. A truly collaborative research project, examining an extensive data set and incorporating the sophisticated methodological and statistical techniques of sociologists, would hold the promise of yielding more informative results regarding the nature of bio-socio-environmental influences on antisocial behavior. (See Mednick et al., 1987, for detailed critiques of biological approaches to the study of criminal behavior.)

The discussion that follows concentrates on the biological aspects of this multifaceted relationship because the criminological literature has dealt almost exclusively with sociological and legal issues to the neglect of other interacting conditions. A variety of disciplines have examined maladaptive and psychopathological behaviors, and at least one example from each topical area (e.g., genetics and biology) is discussed.

SELECTED STUDIES OF THE BIOLOGY OF MALADAPTIVE BEHAVIOR

EVOLUTIONARY DICTATES

Human instinctual drives (e.g., eating, reproduction, and defensive behavior) ensure our survival and are essentially stable over time. The mechanisms for acting on these drives, however, especially the brain, continuously evolve to enhance our survival capabilities and have improved substantially. With the advent of human consciousness, psychological forces and cultural values interact and sometimes compete with biological drives dictated by evolutionary trends (Thiessen, 1976). Thus, human behavior is a product of the profound and complex interaction of biological and social conditions. Due to the intricacy of this interaction and the elusiveness of evolutionary directions, the nature and outcome of this process are difficult to identify and to study.

Most behaviors have some adaptive significance (i.e., they reflect an attempt to adapt to environmental conditions) and, thus, can be studied in an evolutionary context. Aggression is one form of behavior that has been extensively studied with respect to its adaptive significance. For example, "abnormal" environmental conditions have been associated with a display of extreme, overt aggression because they are perceived as threats to survival. The administration of an electrical shock or painful stimulus, loud noises, extreme heat, ESB, starvation, crowding, and other conditions elicit or exacerbate fighting behaviors in many primate species, including humans (Carlson, 1977; Thiessen, 1976; Valzelli, 1981). Abnormal environmental conditions characterize prisons and may contribute to the incidence of overt aggressive behavior among inmates; they may also partially explain the relationship between contacts with the criminal justice system (e.g., amount of time incarcerated) and recidivism rates. Also, the prevalence of abnormal environmental conditions has increased with the ever-increasing breakdown of the family structure, community disorganization, disparity between public policy and biological needs, crowding, learned helplessness, and other frequently cited characteristics of U.S. urbanization (Archer and Gartner, 1984:98–117; Larson, 1984:116–141). Investigation of how these deleterious conditions exacerbate maladaptive behavioral mechanisms may eventually lead to socioenvironmental programs to enhance, rather than detract from, adaptive capabilities.

Unfortunately, aggression has been inconsistently defined, and most studies of its evolution and adaptive significance have examined nonhuman animals, probably because of the complexity of human social systems that contribute to the manifestation of aggressive behavior. Due to space limitations and the relative lack of well-supported research in this area, a discussion of evolutionary dictates and aggressive behavior is not included here. The interested reader may refer to Thiessen (1976) and Valzelli (1981) for such discussion.

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GENETIC CONTRIBUTIONS

Research on the genetic components of human behavior suffers in general from numerous methodological and interpretive flaws (Blehar et al., 1988; Clerget–Darpoux et al., 1986; DeFries and Plomin, 1978; Ghodsian–Carpey and Baker, 1987). It is difficult to isolate genetic factors from ontogenetic (developmental) events, cultural influences, early experiences, and housing conditions. As a result, most studies of human behavior have examined the transmission of socioenvironmental factors that can be more empirically observed and manipulated.

Genetic studies of criminal behavior specifically have been even more severely criticized (Mednick et al., 1987; Plomin et al., 1990; Rowe and Osgood, 1984; Walters and White, 1989; Wilson and Herrnstein, 1985). This research suffers from a high level of abstraction because "criminal behavior" is a legalistic label, not descriptive of actual behavior. This weakness is not unique to genetic research, however. Criminal behavior, as a single phenomenon, is far too variable and subject to individual and cultural judgments to be defined for reliable and valid investigation. Instead, research should be predicated on disaggregated behaviors that are reflective of actual acts that can be consistently and accurately measured and examined. Accordingly, genetic studies that focus on criminal behavior per se may be inherently flawed; as criminal behavior is heterogeneous, genetic effects may be more directly associated with particular traits that place individuals at risk for criminal labeling. Mednick et al. (1984) took a first step toward this goal by differentiating violent from property offenders. Concepts such as violent behavior, depression, alcoholism, and psychopathy more aptly reflect an actual behavioral pattern to which specific criteria for their identification can be applied (Plomin et al., 1990). Researchers need only agree on the criteria and measuring instruments.

As a rule, what is inherited is not a behavior; rather, it is the way in which an individual responds to the environment. It provides an orientation, predisposition, or tendency to behave in a certain fashion. Also, genetic influences on human behavior are polygenic—no single gene effect can be identified for most behaviors.

Intellectual deficits, which are closely tied to delinquent and criminal lifestyles (Hirschi and Hindelang, 1977), are understood to be largely heritable (Bouchard and McGue, 1981; Cattell, 1982). Temperamental traits and personality types, possible precursors of maladaptive or criminal behavior, have also been shown to have heritable components in humans, for example, extraversion, depression, alcoholism, dominance, neuroticism, mania, impulsivity, hyperactivity, conduct disorder, sensation seeking, and hyperemotionality (Biederman et al., 1986; Cadoret et al., 1985; DeFries and Plomin, 1978; Ghodsian–Carpey and Baker, 1987; Plomin et al., 1990; Rushton et al.,

1986). Individuals with such personality dispositions, compared with those without, have an increased familial incidence of similar behavioral problems and show differences, along with their family members, in certain biochemical, neuropsychological, and physiological parameters (Biederman et al., 1986; Cadoret et al., 1975; DeFries and Plomin, 1978; Hare and Schalling, 1978; Plomin et al., 1990; Rushton et al., 1986; Tarter et al., 1985; Zuckerman, 1983). The behavioral outcome is contingent on various stressors in the environment, life experiences, and current opportunities. A withdrawn and shy child, for instance, can alter his or her introverted temperament through the self-awareness and training required to become a more, outgoing adult, given the availability of necessary personal and external resources.

Numerous studies have attempted to estimate the genetic contribution to the development of criminality, delinquency, aggression, and antisocial behavior. Each has used one of three methods designed to assess the relative contributions of environment and heredity to various aspects of human behavior: family, twin, and adoption studies. Overall, many of these behavioral genetic studies suffer from one or more of the methodological weaknesses discussed earlier. Genetic research designs and selected seminal studies are briefly described below. (Only a few researchers have comprehensively and critically reviewed the bulk of these studies; see Mednick et al., 1987; Plomin et al., 1990; Walters and White, 1989; Wilson and Herrnstein, 1985.)

Family Studies

The family study seeks to identify genetic influences on behavioral traits by evaluating similarities among family members. Cross-generational linkages have been reported for personality and behavioral attributes related to criminal behavior, including temper outbursts (Mattes and Fink, 1987), sociopathy (Cloninger et al., 1975, 1978; Guze et al., 1967), delinquency (Robins et al., 1975; Rowe, 1986), hyperactivity and attention deficit disorder (Cantwell, 1979), conduct disorder, aggression, violence, and psychopathy (Bach–y–Rita et al., 1971; Stewart et al., 1980; Stewart And DeBlois, 1983; Stewart and Leone, 1978; Twito and Stewart, 1982).

Despite conclusions from many of these studies that genetic effects are largely responsible for criminal behavior, this method of study does not directly assess genetic contributions. Environmental influences on measures of behavior may be common to parents and offspring, and thus, large environmental correlations among relatives cannot be accounted for. Diet, environmental toxins, neighborhood conditions, and television-viewing habits are only a few examples of environmental factors that similarly influence family members. Family studies also suffer from many of the weaknesses listed above. At this point, one may only conclude that the incidence of criminal

and related behaviors appears to have a familial basis. The relative influences of genetics and environmental conditions cannot, however, be estimated.

Twin Studies

The classic twin design involves the testing of identical (monozygotic or MZ) and fraternal (dizygotic or DZ) twins. MZ twins share genetic material from the biologic parents and are thus considered genetically identical. DZ twins are approximately 50% genetically alike, as are regular siblings. The extent to which MZ resemblances with respect to a characteristic are greater than DZ resemblances provides evidence for a genetic influence on the variable. To the extent that there is still some degree of DZ resemblance after genetic influences have been accounted for, there is evidence for the influence of common family environment on the variable. For example, if a sample of MZ twins is 60% similar for IQ and a matched sample of DZ twins is 25% similar for IQ, one can conclude that IQ is largely a function of heredity.

Christiansen (1977b) reviewed nine twin studies on criminal behavior, including his own exemplary study (Christiansen, 1977a). Overall, the studies provide evidence for a genetics-environment interaction (see discussion in Wilson and Herrnstein, 1985). Dalgard and Kringler's (1976) findings were the exception. Although they found a trend, they did not find statistical significance for differences between MZ and DZ criminality. More current twin studies have found significant genetic effects for both self-report and official rates of delinquent or criminal behavior (Rowe, 1983; Rowe and Osgood, 1984) and personality or temperamental traits related to criminal behavior, for example, aggression (Ghodsian–Carpey and Baker, 1987; Rowe, 1986; Rushton et al., 1986; Tellegen et al., 1988). Two additional studies did not find significant MZ-DZ differences in concordance rates for childhood aggression (Owen and Sines, 1970; Plomin et al., 1981). Plomin et al. (1990) examined numerous twin studies of criminal/delinquent behavior and aggression and noted that the results were highly inconsistent, possibly because no uniform measure of self-reported aggression and its constructs has been applied.

Twin studies commonly suffer from a number of unique methodological weaknesses (Plomin et al., 1980). First, MZ twins are selected more frequently due to their visibility, and study group sizes thus become disproportionate. Second, sampling techniques may favor the selection of MZ pairs that are similar in relevant behavioral traits, which biases the results. Third, MZ twins tend to share more similar environments than do DZ twins because of their similar appearance (DZ twins look no more alike than regular siblings). Because environmental assessments are not commonly conducted, such similarities cannot be estimated to determine their relative influence. In favor of the validity of the twin method, however, is evidence that physical

and environmental similarities among MZ twins do not bias studies of personality (see DeFries and Plomin, 1978:480; Plomin and Daniels, 1987). Fourth, only recently have researchers employed biochemical tests to verify the zygosity of the twins. The bulk of genetic studies were performed prior to the ready availability of such tests, and thus, the genetic influence may have been underestimated. Fifth, measurement errors may further increase the tendency to underestimate genetic influences. On the other side of the coin, the twin method can only examine the level of genetic contribution over and above environmental influence. Thus, there is contamination from an unknown amount of environmental contribution and the influence of heredity may be overestimated.

No definitive conclusions can be drawn from twin studies of aggressiveness or criminal behavior because no consistent pattern of genetic influence emerges. Nevertheless, twin studies of criminal and related behaviors fairly consistently provide some intriguing evidence for a genetic effect, and genetic influences warrant continued, but more rigorous, study.

Adoption Studies

Adoption studies examine individuals who were raised from infancy by nonrelated adoptive parents rather than biological relatives. To the extent that subjects resemble the biological relatives and not the nonbiologic relatives, heredity is thought to play a contributory role. The adoption study method promises to provide unambiguous evidence for the relative contribution of heredity as a cause for behavioral traits and for genetics-environment interactions. Nevertheless, the method has some weaknesses (see Walters and White, 1989, for examples). First, due to difficulties in locating subjects, sample sizes tend to be small, which reduces the power of the results. Second, selection bias may be introduced in the adoption process because assignment to adoptive parents may not be random with respect to biological parent characteristics. Third, a primary criticism of a majority of adoption studies on criminality is the inadequacy and inconsistency of the methods used to operationalize and measure the dependent variable (see Plomin et al., 1990; Walters and White, 1989). Fourth, researchers should ensure that the duration and type of biological parenting similar among all subjects to avoid contamination. Ideally, infants should have been adopted within a few weeks of birth so that the age of adoption does not relate to subsequent criminal behavior (see Mednick, et al., 1984).

Several adoption studies indicate noteworthy genetic effects on criminal or delinquent behavior and related psychopathology (i.e., psychopathy).[6] For

6. For the former see Cloninger et al. (1982), Crowe (1972), Hutchings and Mednick (1975), Mednick et al. (1984), Sigvardsson et al. (1982); for the latter see Cadoret (1978), Cadoret et al. (1985), Crowe (1974), Schulsinger (1985).

the most part, these studies suggest that biological relatives of criminal or antisocial probands have a greater history of criminal convictions or antisocial behavior than the biological relatives of noncriminal control adoptees. In general, family environment, including such indices as social class, rearing styles, and parental attitudes, played a smaller role than did purported genetic effects.

Bohman et al. (1982) further argue that genetic influences on criminality may differ from those who are also alcoholic. Specifically, when the biological parents are both criminal and alcoholic, crimes of adoptees tend to be more violent. There is no direct evidence, however, that criminality/antisocial personality and alcoholism are genetically linked to the same antecedent conditions. Nevertheless, the link between the two behaviors has been widely documented (see Cadoret et al., 1985).

Adoption studies highlight the importance of gene-environment interactional models (Rowe and Osgood, 1984). Mednick et al. (1984) proposed that having a criminal adoptive parent most profoundly affects those with a genetic propensity for criminality. In other words, those who inherited certain antisocial personality and temperamental traits are more likely to manifest criminal behaviors in the presence of deleterious environmental conditions (e.g., criminal parents). Even though these conditions interact to produce antisocial behavior, many researchers attest that environmental and genetic factors differentially influence behavior and that their relative contributions may be measurable (see Plomin et al., 1990).[7]

BIOLOGICAL CONTRIBUTIONS

Genetic foundations for behavioral disorders are manifested in a phenotype, which is the resulting, visible expression of a genetic trait. For example, one may have the genetic blueprint (or genotype) for brown and blue eyes, but the final, observable eye color (the phenotype) is brown. Although researchers can rarely trace a behavioral disorder to a specific gene, they can more aptly measure the manifestation of a genetic blueprint in nervous system features. Other biological traits associated with behavioral problems are not directly genetic in origin; they may be due to mutations in a genetic constitution, biochemical exposures, or a deleterious social environment. All of these conditions, from the genetic to the environmentally precipitated, exert their influence on the nervous system and, thus, can be measured and manipulated. The following correlates of behavioral disorders illustrate selected ways in which genetic and environmental factors impact on the nervous system to alter behavior.

7. Plomin and Daniels (1987) provide convincing evidence that genetic influences may explain within-family resemblances and that environmental influences more aptly explain within-family differences.

BIOLOGICAL PERSPECTIVES 47

BIOCHEMICAL CORRELATES

A number of biochemical differences have been found between controls and individuals with psychopathy, antisocial personality, violent behavior, conduct disorder, and other behaviors associated with criminal behavior. These groups have been discriminated on the basis of levels of certain hormones, neurotransmitters, peptides, toxins, and metabolic processes (Brown et al., 1979; Davis et al., 1983; Eichelman and Thoa, 1972; Mednick et al., 1987; Rogeness et al., 1987; Roy et al., 1986; Valzelli, 1981; Virkkunen and Narvanen, 1987).

Current investigations of biochemical mechanisms of aggressiveness focus on the study of central neurotransmitter systems. Observations from animal and human studies, for example, indicate that serotonin, a neurotransmitter, globally inhibits behavioral responses to emotional stimuli and modulates aggression (Muhlbauer, 1985; Soubrie, 1986; van Praag et al., 1987). Several indicators of lower levels of serotonin activity in individuals characterized as violent or impulsive, in comparison with those who are not, have been reported (Brown et al., 1979; Fishbein et al., 1989; Linnoila et al., 1983; Virkkunen et al., 1987, 1989). These studies indicate that serotonin functioning is altered in some types of human aggressiveness and violent suicidal behavior. Thus, a decrease in serotonergic activity may produce disinhibition in both brain mechanisms and behavior and result in increased aggressiveness or impulsivity.

Findings of reduced serotonergic activity among individuals with impulsivity and aggressivity are well supported by behavioral and personality studies of animals and humans. Nevertheless, this research is relatively new to the area of antisocial behavior and frequently suffers from theoretical and methodological inadequacies (see Soubrie, 1986). First, categorizing subjects according to their behavioral attributes has been inconsistent across studies, and group assignment within studies is, in some cases, controversial. Second, because aggression is not a unitary phenomenon it is important to determine whether serotonergic activity levels are specific to types of aggression or whether they globally regulate aggression. Third, psychopathy or antisocial personality is frequently used to describe subjects without respect to the presence of trait anxiety (see above), which is known to involve serotonergic systems (Soubrie, 1986). This confusion may produce findings that are inconsistent and lack functional significance (van Praag et al., 1987). And fourth, serotonergic activity is all too often studied in isolation of other interacting biological systems. Thus, these studies have not been able to identify precisely the neural mechanisms for regulating aggression. They do, nevertheless, bring us closer to identifying neurobiological mechanisms for aggression, impulsivity, and antisocial behavior.

There is a noticeable absence of research on female criminality in general,

and reports that do exist are largely sociological or anecdotal. Widom (1978) wrote that biological factors contributing to individual differences in temperament, arousal, or vulnerability to stress may be important in the etiology of female criminal behavior. Different socioenvironmental influences may differentially interact with biological sex differences to produce variations in male and female criminality (see, e.g., L. Ellis and Ames, 1987).

There is evidence that high levels of the male sex hormone testosterone may influence aggressive behavior in males (Kreuz and Rose, 1971; Olweus et al., 1988; Reda et al., 1983; Schiavi et al., 1984), although discrepant studies exist (Coe and Levine, 1983). It has been further suggested that sex hormones may also contribute to antisocial behavior in some women. The premenstrual period in particular has been associated with elevated levels of aggressivity and irritability. This phase of the hormonal cycle is marked by an imbalance in the estrogen-progesterone ratio, which may trigger both physical and psychological impairments in a subgroup of women. Sharp changes in mood, depression, irritability, aggression, difficulty in concentration, and substance abuse are only a few behavioral disturbances that typify premenstruation in affected women (Haskett, 1987; Trunnell and Turner, 1988).

A significant number of females imprisoned for aggressive criminal acts were found to have committed their crimes during the premenstrual phase, and female offenders were found to be more irritable and aggressive during this period (Cooke, 1945; Dalton, 1964, 1966; D. Ellis and Austin, 1971; Morton et al., 1953; see D'Orban and Dalton, 1980, and Epps, 1962, for negative findings). Overall, most of these studies have been criticized for serious methodological shortcomings (see Harry and Balcer, 1987). Nevertheless, there remains a general impression among investigators and clinicians that a small number of women appear to be vulnerable to cyclical changes in hormonal levels, which causes them to be more prone to increased levels of anxiety and hostility during the premenstrual phase (Carroll and Steiner, 1987; Clare, 1985). Ginsburg and Carter (1987) provide a thorough discussion of the controversy about premenstrual syndrome, including evidence for its existence, its association with behavioral disorders, and the legal, social, and biomedical implications. Because premenstrual syndrome is difficult to diagnose and its etiology is still under investigation, an association between the menstrual cycle and female criminal behavior is too remote and indirect to be conclusive at this time.

Exposure to toxic trace elements is yet another factor that has been shown to interfere with brain function and behavior. Chronic or acute exposure to lead, for example, has a deleterious effect on brain function by damaging organ systems, impairing intellectual development, and subsequently interfering with the regulation of behavior. Sources of lead include our diet and environment (e.g., paint chips and house dust), and contamination among

children may be serious and grossly underestimated (Bryce–Smith and Waldron, 1974; Moore and Fleischman, 1975). Resulting impairments may be manifested as learning disabilities and cognitive deficits, particularly in measures of school achievement, verbal and performance IQ, and mental dullness (see Benignus et al., 1981; Lester and Fishbein, 1987; Pihl and Parkes, 1977). Because of the high correlation among school failure, learning disabilities, and delinquency, lead intoxication is a relevant criminological issue.

A growing body of research has further demonstrated that lead intoxication is significantly associated with hyperactivity and impulsivity (David et al., 1972; Needleman et al., 1979), putative precursors to delinquency, and criminal behavior (Denno, 1988). Following chelation (removal) of lead from the body, David et al. (1976) found behavioral improvements among hyperactive children. Pihl et al. (1982) reported that violent subjects had significantly elevated concentrations of lead compared with nonviolent criminals. They further suggest that subtoxic levels of lead have a potential effect on behavior and that lead detection can be an important diagnostic procedure. Children who are at risk for exposure to lead also tend to have poor diets, that is, diets low in calcium and iron, which help to protect the body from lead's effects. Many of these studies lack proper control groups and double blind procedures, yet accumulating evidence strongly suggests that, given other deleterious socioenvironmental conditions, an individual exposed to lead is more likely to manifest maladaptive behavior (see Rimland and Larson, 1983, for a review of studies).

Psychophysiological Correlates

Psychophysiological variables, for example, heart rate, blood pressure, attention and arousal levels, skin conductance, brain waves, and hormone levels, are quantifiable indices of nervous system function. These measurable conditions directly reflect emotional responses and can be experimentally manipulated in human populations.

Studies of criminal behavior, aggression, and psychopathy have repeatedly found psychophysiological evidence for mental abnormality and central nervous system disturbances as putative markers for criminal behavior. For example, psychopaths have been found to differ from nonpsychopathic controls in several physiological parameters. These indices include (a) electroencephalogram (EEG) differences, (b) cognitive and neuropsychological impairment, and (c) electrodermal, cardiovascular, and other nervous system measures.[8]

8. For (a), see Hill and Watterson (1942), Howard (1984), Mednick et al. (1981), Syndulko et al. (1975), Volavka (1987), Yeudall et al. (1985); for (b), see Bryant et al. (1984), Hurwitz et al. (1972), Jutai and Hare (1983), Lewis et al. (1985, 1986, 1988), Pontius and Yudowitz (1980), Raine and Venables (1987), Sutker and Allain (1987); and for

In particular, psychopathic individuals have been found to show relatively more slow wave activity in their spontaneous (that is, when resting with no provocation) EEG compared with controls, which may be related to differences in cognitive abilities (Hare, 1970; Howard, 1984; Pincus and Tucker, 1974; Syndulko, 1978). Some investigators have suggested that relatively high levels of EEG slowing in psychopathic subjects reflect a maturational lag in brain function (Kiloh et al., 1972; Pontius and Ruttiger, 1976). Thus, EEG slowing among individuals who also demonstrate immature behavior and an inability to learn from experience supports a maturational lag hypothesis. It may be suggested that EEG slowing among some psychopaths is consistent with findings of hypoaroused autonomic function (see above) and other differences in psychophysiologic parameters. Their need for external stimulation may be higher and more difficult to satisfy than in other populations due to a lower level of internal stimulation.

Psychopharmacological Inducements

Psychopharmacology is the study of the psychological and behavioral aspects of drug effects on brain metabolism and activity. Aggression, for example, can be elicited or extinguished by the administration of a pharmacologic agent. In fact, the pharmacologic treatment of aggressive and violent behavior has become increasingly popular and its efficacy in many cases has been demonstrated (Kuperman and Stewart, 1987; Lion, 1974, 1979; Yudofsky et al., 1987). Certain drugs, particularly many of the illicit drugs, are reported to increase aggressive responses, for example, amphetamines, cocaine, alcohol, and phencyclidine (PCP). The actual expression of aggressive behavior depends on the dose, route of administration, genetic factors, and type of aggression.

Several biological mechanisms have been proposed as explanations for alcohol-induced aggression: (1) pathological intoxication, sometimes involving psychomotor epilepsy or temporal lobe disturbance (Bach–y–Rita et al., 1970; Maletsky, 1976; Marinacci, 1963); (2) hypoglycemic reactions (low blood sugar; Cohen, 1980; Coid, 1979; Wallgren and Barry, 1970); and (3) alterations in neurotransmitter activity (Weingartner et al., 1983). These explanations do not completely account for the relationship, however, because most drinkers do not become aggressive. Indications are that alcohol either changes the psychological state or the psychological state has an effect on the behavioral outcome of alcohol consumption. In the second scenario, alcohol would stimulate an existing psychiatric condition or psychological predisposition to aggress or misbehave (Pihl and Ross, 1987). Hence, alcohol

(c), see Allen et al. (1971), Hare (1978), House and Milligan (1976), Lykken (1957), Mednick et al. (1982), Waid et al. (1979).