BIOLOGICAL PERSPECTIVES IN CRIMINOLOGY* by Diana H. Fishbein, University of Baltimore
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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 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 relevance 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.

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 crimi\-nology 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 lines, 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 [sic]; 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. Manifestations of a problem are frequently 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.[ii] 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 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 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.[iii]

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 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 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.\[v]\n
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.

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.

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 phenotype, 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 life styles (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, extra version, 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; Zucker, 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-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). For 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).[vii]

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.

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 Walldron, 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.

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 psychophysiological 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 does not appear to "cause" aggression, but rather permits its expression under specific circumstances and biological conditions.

Chronic use of PCP, an illicit drug that is commonly used in combination with marijuana, has been repeatedly associated with extreme violence to self and others in individuals both with and without histories of violent behavior (Aronow et al., 1980; Fauman and Fauman, 1980; Linder et al., 1981; Schuckit and Morrissey, 1978; Seigal, 1978; Smith and Wesson, 1980). Violent reactions appear, according to some anecdotal reports, to be an extension of PCP toxic psychosis, which affects some users (Fauman and Fauman, 1980). Because only a subpopulation of users manifest violent behavior and some studies (e.g., Khajawall et al., 1982) did not find a relationship between PCP use and violence, additional research is needed to (1) determine whether PCP reliably elicits aggressive behavior among vulnerable users, (2) identify underlying mechanisms in PCP-induced aggression, and (3) determine the
nature of the vulnerability that causes certain individuals to be particularly susceptible to that behavioral effect.

Investigators recognize that PCP effects result from a complex interaction among physical, psychological, and sociocultural variables (Smith and Wesson, 1980). PCP-related aggression may be due to influences on hormonal and neurotransmitter activity (Domino, 1978, 1980; Marrs et al., 1988). Also, neuropsychological impairments have been observed that minimally reflect a temporary organic brain syndrome (Cohen, 1977; Smith and Wesson, 1980). Additional studies of PCP users indicate that specific factors in the user’s background, personality, and drug history are important determinants of the drug-related experience (Fauman and Fauman, 1980; McCardle and Fishbein, 1989). As a whole, these observations suggest that the consequences of PCP use, independent of the drug’s purity and varying strengths, are determined by a number of factors, including pharmacological, psychological, and situational.

"Vulnerability" studies suggest that certain personality types may be more at risk for drug abuse than other types (Brook et al., 1985; Deykin et al., 1986; Kellam et al., 1980; McCardle and Fishbein, 1989). This does not mean, however, that these individuals will inevitably become drug abusers due to a natural predisposition. More recent studies provide evidence for the substantial contribution of family support systems in the final determination of whether an individual with a vulnerable personality type will, in fact, abuse drugs (Tarter et al., 1985:346-347). The dynamic interaction between natural and acquired traits in a given environment must always be considered inseparable in the evaluation of such complex phenomenon as human behavior.

IMPLICATIONS FOR CRIMINAL JUSTICE PRACTICES

In order to determine the relevance and significance of biological perspectives for criminology, researchers must estimate the incidence of biological disorders among maladaptive populations, identify etiologic mechanisms, assess the dynamic interaction among biological and socioenvironmental factors, and determine whether improvements in behavior follow large-scale therapeutic manipulations.

At this stage of scientific inquiry in the biological sciences, researchers have yet to determine the significance of biological disorders in criminal populations. Nor are they able to speak of a causal link between biological abnormalities and specific behavioral disorders. They are beginning to identify putative correlates or markers of antisocial behavior using biological tests (e.g., EEG slowing, body lead burden, neurotransmitter imbalance). Some of those correlations may prove to be spurious, but at present, which ones can not be identified. Seen in this light, it would be premature to apply biological findings routinely to criminal justice procedures. Demands for evaluation of causal relationships are made in decisions regarding the granting of bail, release on personal recognizance, competency, guilty pleas, sentencing options, probation and parole, and proclivity to recidivate. Conclusions and prognoses regarding the role of biological factors in an offender’s behavior, however, are not definitive at this time, regardless of the informational source.
To further establish the relevance of biology to criminology, researchers must demonstrate the ability to predict antisocial behavior reliably using a combination of biological and social variables. The central question thus becomes, can more of the variance in the incidence of antisocial behavior be explained with an integrated approach than with a unidisciplinary perspective? Many mental health professionals and researchers have reached a tentative consensus that predicting antisocial behavior with social or legal variables is inherently unreliable (Cocozza and Steadman, 1974; Gottfredson, 1986; Monahan, 1981; Wenk et al., 1972). Is it possible that prediction studies incorporating biological measures into sociological data bases will facilitate the isolation of significant predictors of antisocial behavior and enhance explanatory power?

In the introduction of Brizer and Crowner's recent text (1989) on the prediction of violence, Brizer aptly notes that the actual study of predictive ability suffers from methodological limitations, and thus, one cannot conclude that valid prediction is impossible. Studies reviewed in their text indicate that the inclusion of biological variables (e.g., integrity of central nervous system function) may, indeed, enhance predictive ability if dispositional (temperament and other features considered "innate") and situational factors are considered as interacting forces. In a separate study illustrative of this approach, Virkkunen et al. (1989) examined a selected set of behavioral and psychobiological variables to identify predictors of recidivism in a sample of violent offenders and arsonists. Their results suggested that recidivism is best predicted using a combination of behavioral and psychobiological variables, rather than with behavioral variables alone.

Denno (1988) conducted a fairly comprehensive study of the effects of numerous environmental and biological variables on criminal behavior, juvenile delinquency, and disciplinary problems. The model was able to predict 25% of future adult criminality among males and 19% of future adult criminality among females. Denno drew the following conclusions:

Biological and environmental variables exert strong and independent influences on juvenile crime ... [and] crime appears to be directly related to familial instability and, most important, a lack of behavioral control associated with neurological and central nervous system disorders (p. 659).

She cautions, however, that behavior should be predicted in terms of a series of probabilities of expected behavior, not in terms of cause and effect. Perhaps an approach that neither neglects nor places undue emphasis on socioenvironmental or biological features of behavior provides considerable promise as the direction of future research into practical problems in criminology.

The final stage of scientific inquiry requires that researchers be able to manipulate and control antisocial behavior, in this context with biological variables. Reliable behavioral changes attributable to biological treatments have yet to be demonstrated in this field, however. Biological intervention studies and programs render mixed and controversial results, which indicate that the biology of antisocial behavior is under preliminary stages of investigation and requires further study before it can be applied to criminal justice practices. One particularly visible example of the controversial application of biological data is the pharmacologic treatment of sex offenders. Antianabolic agents (e.g., Depo-Provera), which compete with male hormones believed to be responsible for sexual deviance, are administered in some clinics to suppress sex drive and, consequently, sex offending. Some research indicates that this approach has been moderately successful (Berlin, 1983; Berlin and Meinecke, 1981;
Bradford, 1983; Cordoba and Chapel, 1983; Murray, 1987; Spodak et al., 1978). Others, however, criticize the approach because of (1) the equivocal findings that provide empirical support, (2) the fact that the behaviors resurface when the drug is discontinued, (3) its strictly experimental nature, (4) the issue of forced compliance, and (5) evidence that only nonviolent sex offenders respond to antiandrogen treatment (see Demsky, 1984). Such biological management techniques require further scientific support and, even more important, time for the legal system to become acquainted with their premises in order to establish appropriate guidelines.

It is perhaps unreasonable to expect dramatic behavioral improvements following a biological treatment, even when a disorder has been properly diagnosed. One of the central tenets of this paper is that behavior is a result of a dynamic interaction among many diverse social and biological conditions. The appropriate administration of a medication or other treatment may certainly be warranted for some individuals with identifiable pathology. However, this approach undermines the proposal that multiple factors are responsible for behavior. One cannot manipulate biological variables and expect behavior to change without attending to other interacting contributions. Once an individual has entered the criminal justice system, behavioral problems are substantially compounded and the treatment of only one condition does not yield adequate therapeutic results.

Findings of biological involvement in antisocial behavior have, in a few studies (e.g., Lewis et al., 1979, 1981, 1985, 1986, 1988), disclosed measurable abnormalities, but in a number of studies, measurements do not reach pathological levels. In other words, many studies show group differences between violent and nonviolent subjects, but the biological values do not necessarily exceed normal limits and would not alarm a practicing physician. Findings of this type do not have intrinsic clinical significance, and they indicate that individual intervention programs should not be globally implemented based on current information.

Nevertheless, at the very least, the inclusion of biological measures holds promise of explaining individual variation within a social context. Why is it, for example, that not all children exposed to child abuse become violent as adults? Research into individual differences may be interpreted to suggest that whether child abuse contributes to violent behavior partially depends on the presence of brain damage or other central nervous system disorder (Lewis et al., 1979). Perhaps abused children without concomitant or resultant brain damage would be less aggressive and more in control of their impulses. Research yet to be conducted may also show that individuals with biological "disadvantages" respond with more violent or criminal behavior in a criminalogenic environment than those equipped with biological "insulators," for example, high intelligence or adequate serotonergic activity.

Statistically significant findings generated to date show biological involvement in antisocial behavior only with respect to populations. Thus, society is closer to enacting prevention programs aimed at populations who are at risk for exposure to biological and socioenvironmental hazards that are known to increase the incidence of behavioral problems. Factors that may prove to be important contributors to relevant behavioral disorders (e.g., toxic element concentrations, child abuse/neglect, poor prenatal care, neurological impairments, substance abuse, and learning disabilities) could subsequently be manipulated on a wide scale to prevent the onset of behavioral or forensic disorders in the general population. Early detection programs could be implemented by school systems, and parents could be educated to recognize signs of an impairment. Screening clinics, regulating environmental toxins, school
programs, prenatal care facilities, and public educational programs are only a few of the preventative measures possible. The number of "risk" factors could, in essence, be reduced or minimized.

An excellent example of this strategy was suggested by Moffitt et al. (1989) in their review of minor physical anomalies (MPAs), that is, observable minor malformations that result from a disturbance in fetal development. MPAs are thought to be indicators of other hidden anomalies, such as central nervous system impairment, that may result from some perinatal trauma (e.g., illness, poor diet, drug use, stress). Further, a relatively large number of MPAs have been observed among hyperactive and criminally violent populations. Obviously, there is no acceptable mode of individual remediation in such cases, particular because of the remote association of MPAs with behavior. These consistent observations, however, emphasize the need for a global effort to provide proper prenatal care. Consequently, society can hope to reduce the incidence of developmental deficits related to the onset of behavioral disorders by recognizing their possible influence.

CLOSING COMMENTS

How biological variables interact with social and psychological factors to produce human behavior generally and antisocial behavior specifically is unknown. The bulk of biological studies, both those described herein and others not included, have examined only a few isolated variables and have generally failed to evaluate dynamic interrelationships among biological and socioenvironmental conditions (see Denno, 1988, and Wilson and Herrnstein, 1985, for detailed critiques). In order to evaluate the relative significance of biological contributions to antisocial behavior, sophisticated, statistical techniques (i.e., structural equation models) must be applied to multivariate designs that use rigorous measurement instruments. Studies of biological influence would benefit greatly from adopting the methodological and statistical techniques of sociologists to increase the rigor and relevance of the findings.

Caution against the premature application of biological findings is clearly called for. The weaknesses in design, sampling techniques, and statistical procedures delineated above preclude drawing definitive conclusions, and results are frequently contested and unreliable. Policies and programs based on equivocal and controversial findings waste time and money and potentially compromise individual rights and community safety. A number of legal, ethical, and political obstacles to the acceptance and application of biological and medical information by the criminal justice system are covered extensively elsewhere (Fishbein and Thatcher, in press; Jeffery, 1985; Marsh and Katz, 1985). At the very least, care must be taken not to stigmatize or otherwise traumatize individuals or groups that are, as yet, innocent of a criminal or civil violation. As researchers, we must avoid applying labels to behaviors we do not understand. In the event that biological measures are shown to be reliable and valid predictors of behavior and mental status, several serious civil rights and constitutional issues related to early identification and intervention in the absence of a proven violation of law would demand careful consideration. In cases in which a conviction is upheld, for example, forced compliance with a "therapeutic regimen" might result from findings that a biological abnormality played a role in an individual's antisocial behavior. One must recognize the numerous legal and ethical concerns generated
by such a strategy. To avoid these transgressions, a collaborative, multidisciplinary approach might be forged strictly to identify the underlying sources of antisocial behaviors and minimize their occurrence in the population.

Overall, evidence to suggest that biological conditions have a profound impact on the adaptive, cognitive, and emotional abilities of the individual is compelling. Investigation of the discriminants for behavioral dysfunctions indicates that the impact of these factors is substantial. When a biological disadvantage is present due to genetic influences or when a physical trauma occurs during developmental stages of childhood, the resultant deficit may be compounded over time and drastically interfere with behavioral functions throughout life. Such conditions appear to place an individual at high risk for persistent problematic behavior. Disturbances associated with poor environmental and social conditions coupled with impaired brain function may eventually be amenable to intervention. The unfortunate reality for those who come into contact with the courts by virtue of their dysfunction, however, is that the underlying causes of their disorder are inaccurately evaluated or simply unattended. The capability to identify and predict the factors responsible for maladaptivity may eventually enable society to employ innovative methods of early detection, prevention, remediation, and evaluation.

Criminal justice policies must be based on well-founded theories and findings that survive scientific scrutiny. The application of scientific principles or findings to criminal justice programs that are well recognized and accepted by the discipline have more value than trial-and-error approaches in preventing or minimizing the onset of criminal behavior. Although biological techniques in the assessment of human behavior are still under the microscope and definitive answers have yet to surface, the foregoing description of biological foundations for behavior provides evidence of their applicability and value. The study of biological drives may also help to explain the development of specific social structures and control mechanisms (Jeffery, 1977; Pugh, 1977; Thies, 1976).

Biological perspectives, for example, may enhance understanding of how certain control techniques employed throughout the criminal justice system, particularly in corrections, operate to further criminal activities through prisonization, crowding, dehumanization, and so forth. Use of this information in court or in policymaking can still be contested. Nevertheless, by undertaking a collaborative strategy, researchers can hope to develop more effective programs to reduce the incidence of antisocial behaviors (e.g., violence) and develop a legal system that reflects public consensus, meets human needs, and maintains an ethical and organized social structure.

REFERENCES
Allen, H., L. Lewis, H. Goldman, and S. Dinitz

American Psychological Association

Archer, D. and R. Gartner

Aronow, R., J.N. Miceli, and A.K. Done

Bach-y-Rita, G., J.R. Lion, and F.R. Ervin

Bach-y-Rita, G., J.R. Lion, C.E. Climent, and F.R. Ervin
Benignus, V.A., D.A. Otto, K.E. Muller, and K.J. Seiple


Berlin, F.S.


Berlin, F.S. and C.F. Meinecke


Blackburn, R.


1986 Patterns of personality deviation among violent offenders: Replication and extension of an empirical taxonomy. British Journal of Criminology
26:254·269.


Blehar, M.C., M.M. Weissman, E.S. Gershon, and R.M.A. Hirschfeld


Bohman, M., C.R. Cloninger, S. Sigvardsson, and A-L. von Knorring


Bouchard, T.J., Jr., and M. McGue


Bradford, J.


Brizer, D.A. and M. Crowner


Brook, J.S., S. Gordon, and M. Whiteman


Bryant, E.T., M.L. Scott, C.J. Golden, and D.C. Tori


Bryce-Smith, D. and H.A. Waldron


Cadoret, R.J.


Cadoret, R.J., L. Cunningham, R. Loftus, and J. Edwards


Cadoret, R.J., T.W. O'Gorman, E. Troughton, and E. Heywood


Cantwell, D.P.

Carlson, N.R.


Carroll, B.J. and M. Steiner


Cattell, R.B.


Christiansen, K.O.


Clare, A.W.


Cleckley, H.

Clerget-Darpoux, F., L.R. Goldin, and E.S. Fershon


Cloninger, C.R., T. Reich, and S.B. Guze


Cloninger, C.R., K.O. Christiansen, R. Reich, and I.I. Gottesman


Cloninger, C.R., S. Sigvardsson, M. Bohman, and A-L. von Knorring


Cozozza, J.J. and H.J. Steadman


Coe, C.L. and S. Levine


Cohen, S.


Coid, J.

Cooke, W.R.

Cordoba, O.A. and J.L. Chapel

Critchley, E.M.R.

Crowe, R.R.

Dalgard, O.S. and E. Kringler

Dalton, K.


David, O.J., J. Clark, and K. Voeller


David. O.J., S.P. Hoffman, J. Sverd, J. Clark, and X. Voeller


Davis, B.A., P.M. Yu, A.A. Boulton, J.S. Wormith, and D. Addington


DeFries, J.C. and R. Plomin


Demsky, L.S.

Denno, D.W.

1998  Human biology and criminal responsibility: Free will or free ride?

University of Pennsylvania Law Review 137(2):615·671.

Devonshire, P.A., R.C. Howard, and C. Sellars

1988  Frontal lobe functions and personality in mentally abnormal offenders.


Deykin, E.Y., J.C. Levy, and V. Wells


76:178·182.

Domino, E.F.


D’Orban, P.T. and J. Dalton


Eichelman, B.S. and N.B. Thoa

Ellis, L. and M.A. Ames


Ellis, D. and P. Austin


Epps, P.


Eysenck, H.J.


Fauman, M.A. and B.J. Fauman


Fishbein, D.H. and R. Thatcher

in press  Legal applications of electrophysiological assessments. In J. Dywan, R. Kaplan,
Fishbein, D.H., D. Lozovsky, and J.H. Jaffe

Geary, D.C.

Ghodsian-Carpey, J. and L.A. Baker

Ginsburg, B.E. and B.F. Carter

Glueck, S. and E.T. Glueck

Goddard, H.H.
1921 Juvenile Delinquency. New York: Dodd, Mead.
Gottfredson, S.


Gove, W.R. and C. Wilmoth


Guze, S.B., E.D. Wolgram, J.K. McKinney, and D.P. Cantwell


Hamparin, D.M., R. Schuster, S. Dinitz, and J.P. Conrad


Hare, R.D.


Hare, R.D. and D. Schalling

Harry, B. and C. Blacer

Haskett, R.F.

Hill, D. and D. Watterson
1942  Electroencephalographic studies of the psychopathic personality. Journal of Neurological Psychiatry 5:47-64.

Hirschi, T.

Hirschi, T. and M.J. Hindelang

Hooten, E.A.

House, T.H. and W.L. Milligan

Howard, R.C.

Huesmann, L.R., L.D. Eron, M.M. Lefkowitz, and L.O. Walder

Hurwitz, I., R.M. Bibace, P.H. Wolff, and B.M. Rowbotham

Hutchings, B. and S.A. Mednick
Jacobs, P.A., M. Brunton, M.M. Melville, R.P. Brittain, and W. McClemont


Jeffery, C.R.


Jutai, J.W. and R.D. Hare


Kadzin, A.E.


Kagan, J., J.S. Reznick, and N. Snidman


Kandel, E. and S.A. Mednick

Kellam, S.G., J.D. Branch, D.C. Agrawal, and M.E. Ensminger


Kellam, S.G., M.E. Ensminger, and M.B. Simon


Khajawall, A.M., T.B. Erickson, and G.B. Simpson


Kiloh, L.G., A.J. McComas, and J.W. Osselton


Kreuz, L.E. and R.M. Rose


Kuperman, S. and M. Stewart

Larson, C.J.


Lester, M.L. and D.H. Fishbein.


Lewis, D.O., S.S. Shanok, and D.A. Balla


Lewis, D.O., S.S. Shanok, and J.N. Pincus


Linder, R.L., S.E. Lerner, and R.S. Burns


Linnoila, M., M. Virkkunen, M. Scheinin, A. Nuutila, R. Rimon, and F.K. Goodwin

1983 Low cerebrospinal fluid 5-hydroxyindoleacetic acid concentration differentiates impulsive from nonimpulsive violent behavior. Life Sciences 33:2609-2614.

Lion, J.R.


Loeber, R. and T. Dishion


Lombroso, C.

Lykken, D.T.

Maletsky, B.M.

Marinacci, A.A.

Marrs-Simon, P.A., M. Weiler, M.C. Santangelo, M.T. Perry, and J.B. Leiken

Marsh, F.H. and J. Katz

Mattes, J.A. and M. Fink

McCardle, L. and D.H. Fishbein


McManus, M., A. Brickman, N.E. Alessi, and W.L. Grapentine


Mednick, S.A., J. Volavka, W.F. Gabrielli, and T.M. Itil


Mednick, S.A., V. Pollock, J. Volavka, and W.F. Gabrielli, Jr.


Mednick, S.A., T.E. Moffitt, and S.A. Stack

Moffitt, T.E.


Monahan, J.


Moore, L.S. and A.I. Fleischman


Morton, J.H., H. Additon, and R.G. Addison


Muhlbauser, H.D.
1985  Human aggression and the role of central serotonin. Pharmacopsychiatry 18:218·221.

Murray, J.B.


Needleman, H.L., C. Gunnoe, A. Leviton, P. Reed, H. Peresie, C. Maher, and P. Barrett


Olds, J. and P. Milner


Olweus, D.


Olweus, D., A. Mattsson, D. Schalling, and H. Low


Owen, D. and J.O. Sines

Patterson, G.R., B.D. DeBaryshe, and E. Ramsey


Perlmutter, B.F.


Pihl, R.O. and M. Parkes


Pihl, R.O. and D. Ross


Pili, R.O., F. Ervin, G. Pelletier, W. Diekel, and W. Strain


Pincus, J. and G. Tucker

Plomin, R.


44:105 - 111.

Plomin, R. and D. Daniels


1987 Why are children in the same family so different from one another?

Behavioral and Brain Sciences 10:1 - 16.

Plomin, R., J.C. DeFries, and G.E. McClearn


Plomin, R., T.T. Foch, and D.C. Rowe


Plomin, R., K. Nitz, and D.C. Rowe


Pontius, A.A. and K.F. Ruttiger

1976 Frontal lobe system maturational lag in juvenile delinquents shown in

Pontius, A.A. and B.S. Yudowitz

1980 Frontal lobe system dysfunction in some critical actions as shown in the narratives test. The Journal of Nervous and Mental Disease 168:111-117.

Poremba, C.


Pugh, G.E.


Quay, H.C.


Rada, R.T., D.R. Laws, R. Kellner, L. Stivastava, and G. Peake


Raine, A.

1988 Psychopathy: A single or dual concept? Personality and Individual

Raine, A. and P.H. Venables
1987 Contingent negative variation, P3 evoked potentials and antisocial behavior.

Richman, N., J. Stevenson, and P.J. Graham

Rimland, B. and G.E. Larson

Robins, L.N.

Robins, L.N., P.A. West, and B.L. Hedanic

1986 Plasma dopamine-B-hydroxylase, HVA, MHPG, and conduct disorder in

Rowe, D.C.


Rowe, D.C. and D.W. Osgood


Roy, A., M. Virkkunen, S. Guthrie, R. Poland, and M. Linnoila


Schiavi, R.C., A. Theilgaard, D.R. Owen, and D. White

Schuckit, M.A. and M.A. Morrissey

Schulsinger, F.

Seigal, R. K.

Sheldon, W.H.

Shonfeld, I.S., D. Shaffer, P. O'Connor, and S. Portnoy

Sigvardsson, S., C.R. Cloninger, M. Bohman, and A.-L. von Knorring
Smith, D.E. and D.R. Wesson

Soubrie, P.

Spodak, M.K., Z.A. Falck, and J.R. Rappeport

Stein, L. and C.D. Wise

Stewart, M.A. and C.S. de Blois

Stewart, M.A. and L Leone
Stewart, M.A., C.S. de Blois, and C. Cummings


Sutker, P.B. and A.N. Allain


Syndulko, K.


Syndulko, K., D.A. Parker, R. Jens, I. Maltzman, and E. Ziskind


Tarter, R.E., A.I. Alterman, and K.L. Edwards


Tellegen, A., D.T. Lykken, T.J. Bouchard, K. Wilcox, N. Segal, and S. Rich

Thiessen, D.D.


Trunnell, E.P. and CW. Turner


Twito, T.J. and M.A. Stewart

1982 A half-sibling study of aggressive conduct disorder. Neuropsychobiology 8:144-150.

Valzelli, L.


van Praag, H.M., R.S. Kahn, G.M. Asnis, S. Wetzler, S.L. Brown, A. Bleich, and M.L. Korn


Venables, P.H.

Virkkunen, M. and S. Narvanen

1987       Plasma insulin, tryptophan and serotonin levels during the glucose tolerance test among habitually violent and impulsive offenders. Neuropsychobiology 17:19 - 23.

Virkkunen, M., A. Nuutila, F.K. Goodwin, and M. Linnoila


Virkkunen, M., J. DeJong, J. Bartkko, F.K. Goodwin, and M. Linnoila


Volavka, J.


Waid, W.M., M.T. Orne, and S.K. Wilson


Wallgren, H. and H. Barry

Walters, G.D. and T.W. White

Watson, J.B.

Weingartner, H., M.V. Rudorfer, M.S. Buchsbaum, and M. Linnoila

Wenk, E.A., J.O. Robison, and G.W. Smith

Widom, C.S.

Wilson, J.Q. and R.J. Herrnstein

Wise, R.
Diana Fishbein has a doctorate in psychobiological criminology from Florida State University and is a faculty member of the Criminal Justice Department, University of Baltimore. She received a fellowship from the National Institute of Health to conduct research at the University of Maryland School of Medicine and has since been on the staff of the Addiction Research Center, National Institute on Drug Abuse.

[i] Antisocial children have a high incidence of adjustment problems, for example, low academic achievement, temper tantrums, conduct disorders, and negative attitudes (see Patterson et al., 1989, for a summary review).


[iii] 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.
[iv] Neurotransmitters and neuropeptides are chemical messengers in the brain that enable brain cells to communicate with each other and other structures.

[v] 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.


[vii] 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.