

HUMAN BIOLOGY AND CRIMINAL RESPONSIBILITY: FREE WILL OR FREE RIDE?

DEBORAH W. DENNO†

Recent research in the genetic and biological sciences has greatly increased our knowledge about the complexity and diversity of human development.¹ Most studies of criminal behavior do not reflect the contributions of these sciences, however, but instead emphasize the role of environmental factors.² Similarly, the courts and the criminal justice system are not willing to address the ethical and philosophical implications of biological research findings on the underlying foundations of the criminal law.³ Apart from those specific behaviors falling under the insanity defense,⁴ the general presumption in the criminal law is that behavior is a consequence of free will.⁵

This philosophy suggests two broad, interrelated questions: Does acknowledging the increasing evidence of biological influences on be-

† B.A. 1974, University of Virginia; M.A. 1975, University of Toronto; Ph.D. 1982, University of Pennsylvania; J.D. Candidate 1989, University of Pennsylvania.

Statistical analyses from the study reported in Part II of this Comment were supported in part by Grant # 85-IJ-CX-0034, awarded by the National Institute of Justice to the Sellin Center for Studies in Criminology and Criminal Law at the Wharton School, University of Pennsylvania. Points of view are those of the author and do not necessarily represent the views of the U.S. Department of Justice.

¹ See J. WILSON & R. HERRNSTEIN, *CRIME AND HUMAN NATURE* 41-66 (1985); Mednick, Pollock, Volavka & Gabrielli, *Biology and Violence*, in *CRIMINAL VIOLENCE* 21, 21-80 (M. Wolfgang & N. Weiner eds. 1982) [hereinafter *Biology and Violence*].

² See Mednick, *Biological Factors in Crime Causation: The Reactions of Social Scientists*, *Introduction to THE CAUSES OF CRIME: NEW BIOLOGICAL APPROACHES* 1, 1-2 (S. Mednick, T. Moffitt & S. Stack eds. 1987).

³ See H. PACKER, *THE LIMITS OF THE CRIMINAL SANCTION* 73-76 (1968); *infra* notes 250-51 and accompanying text.

⁴ See, e.g., Keilitz, *Researching and Reforming the Insanity Defense*, 39 *RUTGERS L. REV.* 289, 293-303 (1987) (providing a review and critique of past and current tests for insanity); Packer, *Homicide and the Insanity Defense: A Comparison of Sane and Insane Murderers*, 5 *BEHAVIORAL SCI. & L.* 25, 33-35 (1987) (discussing significant differences between sane and insane defendants under the Model Penal Code in Michigan during 1980-83).

⁵ See L. TAYLOR, *BORN TO CRIME: THE GENETIC CAUSES OF CRIMINAL BEHAVIOR* 17-20 (1984); see also Norrie, *Freewill, Determinism and Criminal Justice*, 3 *LEGAL STUD.* 60, 60 (1983) ("It is a widely held view among lawyers and legal philosophers that the idea of criminal justice involves the presupposition of the freedom of the will . . ."); cf. Morse, *Failed Explanations and Criminal Responsibility: Experts and the Unconscious*, 68 *VA. L. REV.* 971, 974 (1982) (arguing that the law must accept some notion of subjective mental states when considering appropriate punishments despite the overall presumption of free will in the criminal justice system).

havior slight presumptions of free will in the criminal law? Or does it imply a "free," nonblameworthy ride through the criminal justice system for those with a possible biological deficiency defense?

This Comment examines the role of possible biological deficiency defenses in the criminal law. The topic is inspired by the renewed interest in biological and genetic research on behavior⁶ and the possible use of this research in a variety of criminal defenses in the United States and other countries.

Criminal defendants have introduced biological and medical evidence in a number of celebrated cases over the last twenty-five years. Jack Ruby, who was televised killing alleged presidential assassin Lee Harvey Oswald, was diagnosed as a temporal lobe epileptic;⁷ Oswald himself had a long history of uncontrolled and assaultive behavior.⁸ Both Charles Whitman, who shot forty-one people and killed seventeen in the Texas tower tragedy, and Richard Speck, who murdered eight nurses in Chicago, had evidence of brain disease.⁹ Physicians introduced considerable medical and psychiatric data in the trial of John Hinckley, including CAT scans of Hinckley's brain, that they claimed provided organic evidence that Hinckley was schizophrenic.¹⁰ More recently, lobbyist and former White House aide Michael Deaver attempted to demonstrate that his alcoholism and sedation created a state of amnesia that led him to lie inadvertently to a grand jury and to Congress about details concerning his client relationships.¹¹

Judges and juries have not accepted most of the "new" and highly publicized criminal law defenses. However, the few successful defenses raise concerns about the nature and extent of criminal responsibility. In 1979, for example, Dan White, the former San Francisco supervisor who was accused of murdering Mayor George Moscone and Supervisor Harvey Milk, successfully pleaded diminished responsibility to avoid a first degree murder conviction. He was held unable to tell right from wrong due to a major "mood disturbance," said to be caused in part by

⁶ See Wolfgang, *Foreword* to BIOSOCIAL BASES OF CRIMINAL BEHAVIOR at v (S. Mednick & K. Christiansen eds. 1977).

⁷ See Rodin, *Psychomotor Epilepsy and Aggressive Behavior*, 28 ARCHIVES GEN. PSYCHIATRY 210, 210 (1973).

⁸ See V. MARK & F. ERVIN, VIOLENCE AND THE BRAIN 148 (1970).

⁹ See *id.*

¹⁰ See L. CAPLAN, THE INSANITY DEFENSE AND THE TRIAL OF JOHN W. HINCKLEY, JR. 82 (1984).

¹¹ See Shenon, *Deaver is Sentenced to Suspended Term and \$100,000 Fine*, N.Y. Times, Sept. 24, 1988, at 1, col. 4; Johnston, *Ailing Deaver Is Hospitalized; A Delay for Trial Is Uncertain*, N.Y. Times, Nov. 2, 1987, at A16, col. 1; Safire, *When High Officials Begin Acting Strangely*, N.Y. Times, Oct. 7, 1987, at A31, col. 1; Shenon, *Deaver Cites Alcoholism as Perjury Trial Defense*, N.Y. Times, Oct. 3, 1987, at A6, col. 3.

junk food and extreme stress prior to the killings.¹² Although the jury may have accepted this "twinkie defense" in order to avoid imposing a mandatory death penalty, the defense suggested a growing trend toward biological and psychiatric legal approaches. More recently, Ann Green, after admitting that she had killed her first two children, was found not guilty by reason of insanity in the attempted murder of her third child.¹³ Her case was one of several in this country to use a defense of postpartum illness.¹⁴ Postpartum psychosis, the most serious postpartum illness, follows one to two deliveries per thousand and can involve loss of a sense of reality, delusions, and hallucinations.¹⁵ Because of these kinds of "biological deficiency" cases, the insanity defense, which had recently come under attack as a result of its success in the Hinckley trial,¹⁶ is scrutinized continually.

This Comment presents three major arguments concerning biological deficiency defenses, using, respectively, a critique of biosocial science research, a statistical model of biological and sociological data, and an examination of theories and philosophies on causation and behavior. First, this Comment argues that there should be no defense to mitigate criminal responsibility except in the less than one percent of cases eligible for the insanity defense. Mitigating factors may be considered at the sentencing stage, not for determining the length of the sentence, but only to determine the type of facility for detaining or treatment of a convicted defendant.

Second, this Comment argues that social science research has not successfully demonstrated sufficiently strong links between biological factors and criminal behavior to warrant major consideration in determining criminal responsibility. This conclusion is based upon the results of one of this country's largest studies of the biological and sociological development of individuals from the time of their birth to young

¹² See *Both Sides Rest Their Cases in Moscone Murder Trial*, N.Y. Times, May 15, 1979, at A14, col. 6; *Ex-Supervisor Held Unable to Tell Right from Wrong*, N.Y. Times, May 8, 1979, at A16, col. 6 (referring to the expert testimony of a psychiatrist).

¹³ See Sullivan, *Jury, Citing Mother's Condition, Absolves Her in 2 Babies' Deaths*, N.Y. Times, Oct. 1, 1988, at 29, col. 2.

¹⁴ See Mansnerus, *The Darker Side Of the 'Baby Blues'*, N.Y. Times, Oct. 12, 1988, at C1, col. 1.

¹⁵ See *id.* at C8, cols. 2-3.

¹⁶ See, e.g., Fentiman, "Guilty but Mentally Ill": *The Real Verdict is Guilty*, 26 B.C.L. REV. 601, 603 (1985) ("As a direct result of [the Hinckley] verdict, over sixty bills were introduced in Congress aimed at either restricting or eliminating the insanity defense for federal defendants."); McGraw, Farthing-Capowich & Keilitz, *The "Guilty but Mentally Ill" Plea and Verdict: Current State of the Knowledge*, 30 VILL. L. REV. 117, 124-25 (1987) ("[T]he trial acquittal of John W. Hinckley, Jr. . . . apparently influenced many federal and state legislators to introduce [Guilty but Mentally Ill] legislation.").

adulthood. Social science research, however, can be valuable in other contexts, such as predicting bias in death penalty sentencing, in which measures are better defined and there is a lesser burden of statistical proof.

Third, this Comment demonstrates that no strong evidence supports either a strictly free will or a strictly deterministic philosophy in the criminal law regarding either the causes of crime or the determinants of criminal responsibility. Moreover, the notion of "cause" has varying implications depending on the context. Statistical models of biosociological research support a philosophy of "degree determinism," however, that spans a lifetime. The criminal law should reflect this philosophy rather than a free will fiction.

Ultimately, the criminal justice system must confront the significance of the mounting evidence concerning the biological bases of behavior, weigh its importance, evaluate its strengths and weaknesses, and recommend a policy for its use. The direction of that policy will depend upon our notions of human nature, our assumptions of causality, and, undoubtedly, the politics and potentially broad applicability of the biological deficiency argument.

In the discussion that follows, the terms "biological" and "environmental" are loosely defined because of their close association with related terms and with one another. Generally, "biological" factors will be considered as "nonsocial, nonbehavioral measures of . . . constitution and functioning,"¹⁷ such as different chromosome patterns and biochemical effects. "Environmental" factors will include effects without a biological base, such as family income. Factors comprising "behaviorally-defined characteristics," like cognitive or intellectual ability and achievement, may have a partial biological base¹⁸ that, presumably, can be environmentally perpetuated or altered.

This Comment has four Parts. Part I outlines some selected theories and research on genetic, biological, sociological, and environmental influences on criminal behavior. Criminal law cases and defenses that have used this research are discussed and criticized. Likewise, many of these theories are tested together in Part II, which examines research results from a longitudinal¹⁹ study of juvenile and adult crime in order to assess the rationale and desirability of a biological deficiency defense. This Comment then applies the results of this study's statistical model

¹⁷ *Biology and Violence*, *supra* note 1, at 22.

¹⁸ *See id.*

¹⁹ *See Singer, Longitudinal Data Analysis*, in *ENCYCLOPEDIA OF STATISTICAL SCIENCES* 142, 142 (S. Kotz & N. Johnson eds. 1985) (defining longitudinal data analysis as a statistical subspecialty that traces individual histories over time).

to develop a probability theory of behavior, which is discussed in Part III in the context of arguments supporting both free will and deterministic notions of criminal responsibility. Part III argues that a theory of "degree determinism"²⁰ more accurately reflects what have previously been called cause-and-effect relationships. Part III also assesses the feasibility of a biological deficiency defense given the problems posed by other proposed criminal defenses, such as Vietnam Stress Syndrome. Part IV concludes with a commentary on the appropriate and inappropriate uses of social science research and its relation to the goals and philosophy of the criminal justice system.

I. BIOLOGICAL AND ENVIRONMENTAL EXPLANATIONS OF CRIME

A. Genetic Evidence

Historically, biological explanations of criminality are traced to the research of Cesare Lombroso, an Italian physician,²¹ and his doctrine of evolutionary atavism²² first published in 1876 in *L'Uomo Delinquente*. Lombroso's belief that criminals possess an innate, and in some ways primitive, predisposition toward crime was later refuted and criticized extensively,²³ as was subsequent biological research on criminals conducted in the United States.²⁴

Such dubious beginnings have continued to cast suspicion on the wave of biological research on crime conducted in the last two decades.²⁵ This view may or may not be deserved, depending on the particular study and the conclusions drawn from it. In the late 1960s and 1970s, for example, research focusing on the XYY chromosomal abnormality revealed one of the most controversial links between genetics and

²⁰ See *infra* notes 239-49 and accompanying text.

²¹ See Wolfgang, *Cesare Lombroso, 1835-1909*, in PIONEERS IN CRIMINOLOGY 232, 232 (H. Mannheim ed. 1973).

²² See *id.* at 246-57.

²³ See *id.* at 257-71. For reviews of historical biological theories, see S. SCHAFER, THEORIES IN CRIMINOLOGY 183-202 (1969); Jeffery, *The Historical Development of Criminology*, in PIONEERS IN CRIMINOLOGY, *supra* note 21, at 458.

²⁴ See, e.g., Shah & Roth, *Biological and Psychophysiological Factors in Criminality*, in HANDBOOK OF CRIMINOLOGY 101, 102 (D. Glaser ed. 1974) ("We wish to emphasize that no . . . causal relationship between biological variables and law-violating behavior is being postulated here. Neither do we wish to assert, or even imply, that biological variables by themselves provide a very complete explanation for the complexities of human behavior. We do assert, however, that an understanding of biological determinants is essential in order to obtain a more complete and better understanding of behavior . . .").

²⁵ See Mednick, *supra* note 2, at 1-6 (discussing the hostile reaction of social scientists to the possibility that biological factors are partially responsible for criminal behavior).

crime.²⁶

"Genetically normal" individuals have 46 chromosomes, including one pair of sex chromosomes. The pair of sex chromosomes is called XX for the normal female and XY for the normal male.²⁷ Although a number of different chromosomal deviations can occur,²⁸ the XYY chromosomal abnormality has been studied most extensively in relation to crime and violence, because the extra Y chromosome "suggested the possibility of exaggerated maleness, aggressiveness, and violence."²⁹ Indeed, although the first XYY male discovered was not a criminal and was not abnormally aggressive,³⁰ subsequent research reported a disproportionate number of XYY males in maximum security institutions both in the United States and other countries.³¹

Regardless of these early results, the XYY defense was not successful in the four American cases that attempted to use it in the 1970s. In *People v. Tanner*³² the defendant, charged with kidnapping, forcible rape, and assault with intent to commit murder, was found to have an extra Y chromosome.³³ The two expert witnesses, who were geneticists, stated that their research and that of others demonstrated a causal link between the XYY chromosome disorder and aggressive behavior.³⁴ The court did not accept this link, however, or any argument that the extra

²⁶ The controversy was twofold, reflecting disputes over the actual finding of an XYY chromosome defect as well as the ethical and legal issues that were raised. See Note, *The XYY Chromosome Defense*, 57 GEO. L.J. 892, 892-93 (1969) [hereinafter Note, *Chromosome Defense*].

²⁷ See E. NOVITSKI, HUMAN GENETICS 6-7 (1977).

²⁸ See *id.* at 6-15; see also Craft, *The Current Status of XYY and XXY Syndromes: A Review of Treatment Implications*, in BIOLOGY, CRIME AND ETHICS: A STUDY OF BIOLOGICAL EXPLANATIONS FOR CRIMINAL BEHAVIOR 113, 113-15 (F. Marsh & J. Katz eds. 1985) (discussing the frequency and characteristics of a variety of chromosomal abnormalities, including XXY, YXX, XO, XXX, and XYY); Turner, Robinson, Lang & Purvis-Smith, *Preventive Screening for the Fragile X Syndrome*, 315 NEW ENG. J. MED. 607, 607-09 (1986) [hereinafter Turner & Robinson] (discussing one type of chromosome abnormality).

²⁹ Mednick, *supra* note 2, at 1.

³⁰ See Sandberg, Koepf, Ishihara & Hauschka, *An XYY Human Male*, [1961] 2 LANCET 488, 488-89.

³¹ For reviews of the literature, see L. TAYLOR, *supra* note 5, at 73-82 (discussing the XYY chromosomal deviation); Witkin, Mednick, Schulsinger, Bakkestrom, Christiansen, Goodenough, Hirschhorn, Lundsteen, Owen, Philip, Rubin & Stocking, *Criminality in XYY and XXY Men*, 193 SCIENCE 547, 547-55 (1976) [hereinafter Witkin & Mednick] (reporting results of a large and methodologically sophisticated study demonstrating that XYY males showed evidence of a higher rate of criminality although they displayed no disproportionate tendency toward violence); Note, *Chromosome Defense*, *supra* note 26, at 892-901 (exploring the existing and potential legal issues inherent in the XYY anomaly).

³² 13 Cal. App. 3d 596, 91 Cal. Rptr. 656 (1970).

³³ See *id.* at 598, 91 Cal. Rptr. at 657.

³⁴ See *id.* at 600, 91 Cal. Rptr. at 658-59.

Y chromosome contributes to legal insanity.³⁵ Likewise, the court in *Millard v. State*³⁶ upheld the trial court's refusal to submit the issue of the XYY defendant's insanity to the jury because the expert witness's testimony failed to relate the chromosomal deficiency to a lack of substantial capacity to appreciate the criminality of his conduct.³⁷

The acceptability of the XYY disorder as qualified scientific evidence was the major issue in *People v. Yukl*.³⁸ Yukl, who was charged with the murder of a young woman in his apartment, had just been released from prison for a similar type of murder.³⁹ Yukl requested that a chromosome test be conducted and offered as evidence at trial.⁴⁰ The trial court denied this request, noting that previous cases, such as *Tanner* and *Millard*, had held that XYY evidence failed to meet reasonable standards of "medical certainty."⁴¹ The trial court set forth a new standard:

[I]n New York an insanity defense based on chromosome abnormality should be possible only if one establishes with a high degree of medical certainty an etiological relationship between the defendant's mental capacity and the genetic syndrome. Further, the genetic imbalance must have so affected the thought processes as to interfere substantially with the defendant's cognitive capacity or with his ability to understand or appreciate the basic moral code of his society.⁴²

The requirement of a causal link was consistent with previous cases and also established a set precedent. Thus, in *State v. Roberts*,⁴³ the appeals court affirmed a lower court's denial of the defendant's request for a chromosome test by demanding a showing of causality: "[P]resently available medical evidence is unable to establish a reasonably certain causal connection between the XYY defect and criminal conduct."⁴⁴

A number of factors complicate what some commentators have considered to be a direct link between the XYY chromosome and

³⁵ See *id.* at 600-01, 91 Cal. Rptr. at 659.

³⁶ 8 Md. App. 419, 261 A.2d 227 (1970).

³⁷ See *id.* at 426-28, 261 A.2d at 231-32.

³⁸ 83 Misc. 2d 364, 372 N.Y.S.2d 313 (N.Y. Sup. Ct. 1975).

³⁹ See *id.* at 365, 372 N.Y.S.2d at 315.

⁴⁰ See *id.* at 368, 372 N.Y.S.2d at 317.

⁴¹ See *id.* at 369-72, 372 N.Y.S.2d at 318-20.

⁴² *Id.* at 370, 372 N.Y.S.2d at 319.

⁴³ 14 Wash. App. 727, 544 P.2d 754 (1976).

⁴⁴ *Id.* at 733-34, 544 P.2d at 758 (quoting W. LAFAVE & A. SCOTT, CRIMINAL LAW 334 (1972)).

crime.⁴⁵ First, evidence that XYY individuals have impaired intellectual and physiological functioning suggests that these intervening factors, and not "supermaleness" alone, may be associated with crime.⁴⁶ Second, severe sample size and methodological limitations may lead to inconsistent results in many XYY studies.⁴⁷ Third, a large and methodologically sophisticated study conducted on the relationship between the XYY disorder and crime reported that XYY males did exhibit a higher rate of criminality that was not explained by their subnormal intelligence; however, these males showed no disproportionate tendency toward violence.⁴⁸ In light of the extremely low incidence of the XYY syndrome⁴⁹ and other kinds of genetic abnormalities⁵⁰ in the general population and the inconsistent links between these conditions and crime, serious consideration of an XYY association with crime can be put to rest. Furthermore, the legal community generally has dismissed consideration of the XYY deficiency as a criminal law defense, including the insanity defense.⁵¹

A more general concern, however, is whether other types of genetic factors influence criminality.⁵² A considerable body of research

⁴⁵ See, e.g., L. TAYLOR, *supra* note 5, at 79 (arguing that "the evidence seems to point very clearly to the simple fact that the criminal behavior of the super males was genetically caused, with relatively little effect from social or familial influences").

⁴⁶ See J. WILSON & R. HERRNSTEIN, *supra* note 1, at 100-02; Witkin & Mednick, *supra* note 31, at 547-55; Note, *Chromosome Defense*, *supra* note 26, at 899-901.

⁴⁷ See Kessler & Moos, *The XYY Karyotype and Criminality: A Review*, 7 J. PSYCHIATRIC RES. 153, 160-67 (1970) (identifying several methodological problems associated with XYY studies, including the limited number of XYY males tested so far); Sarbin & Miller, *Demonism Revisited: The XYY Chromosomal Anomaly*, 5 ISSUES IN CRIMINOLOGY 195, 199-201 (1970) (noting, for example, the heavy reliance on single case reports, which could create a sampling bias in most of the studies of the relationship between the XYY karyotype and criminal behavior).

⁴⁸ See Witkin & Mednick, *supra* note 31, at 553-54.

⁴⁹ See *id.* at 550; Note, *Chromosome Defense*, *supra* note 26, at 898-99.

⁵⁰ See Craft, *supra* note 28, at 115-18; Turner & Robinson, *supra* note 28, at 607-09.

⁵¹ See W. LAFAYE & A. SCOTT, CRIMINAL LAW 379-82 (2d student ed. 1986) (reviewing cases and literature on the XYY as a criminal law defense); Note, *The XYY Syndrome: A Challenge to Our System of Criminal Responsibility*, 16 N.Y.L.F. 232, 246 (1970) [hereinafter Note, *XYY Syndrome*] (discussing the trial of John Farley, who unsuccessfully attempted to defend himself in New York on charges of committing a brutal murder and rape based upon an XYY genetic defense). Some scholars nonetheless maintain that the XYY disorder should be considered relevant as a defense to criminal conduct. See Farrell, *The XYY Syndrome in Criminal Law: An Introduction*, 44 ST. JOHN'S L. REV. 217, 218 (1969) (arguing that the relevance of the XYY "as part of an insanity defense should not be opened to serious dispute"); Skeen, *The Genetically Defective Offender*, 9 WM. MITCHELL L. REV. 217, 263-65 (1983) (concluding that the courts should be more open to genetic defenses in the future if trial attorneys are more knowledgeable and prepared).

⁵² See *Biology and Violence*, *supra* note 1, at 23.

has shown, for example, that one or both parents of a disproportionate number of delinquent or antisocial children have criminal or antisocial records.⁶³ Investigation into a possible genetic basis for criminality has

⁶³ See L. ROBINS, *DEVIAN'T CHILDREN GROWN UP: A SOCIOLOGICAL AND PSYCHIATRIC STUDY OF SOCIOPATHIC PERSONALITY* 164 (1966) ("Sociopathic and alcoholic fathers produced a significantly high rate of sociopathic patients (32% vs. 16% for fathers without this diagnosis . . .), but sociopathic and alcoholic mothers did not (27% vs. 21%) . . ."); J. WILSON & R. HERRNSTEIN, *supra* note 1, at 97 ("Whatever is being biologically transmitted appears to intensify with parental criminality, at least for property crimes."); Cadoret, *Psychopathology in Adopted-Away Offspring of Biologic Parents with Antisocial Behavior*, 35 ARCHIVES GEN. PSYCHIATRY 176, 182 (1978) (finding a significant correlation between antisocial behavior of adoptee and biological parent); Cloninger, *The Antisocial Personality*, 13 HOSP. PRAC. 97, 100 (1978) ("If a biologic parent, but neither adoptive parent, was criminal, the incidence [of criminality in the adoptees studied] jumped to about 21% [from 10%.]"); Crowe, *An Adoptive Study of Psychopathy: Preliminary Results from Arrest Records and Psychiatric Hospital Records*, 63 PROC. AM. PSYCHOPATHOLOGICAL A. 95, 100 (1975) (this publication of the 1973 proceedings is also known as GENETIC RESEARCH IN PSYCHIATRY (R. Fieve, D. Rosenthal & H. Brill eds. 1975)) (reporting that offspring of female offenders showed a "significantly higher rate of antisocial behavior leading to arrest" than a control group of adoptees born to nonoffenders); Crowe, *The Adopted Offspring of Women Criminal Offenders*, 27 ARCHIVES GEN. PSYCHIATRY 600, 602-03 (1972) (reporting that adoptees whose biological mothers had recorded criminal convictions had more legal problems than adoptees from a control group with mothers who had not been convicted); Lewis, Balla, Shanok & Snell, *Delinquency, Parental Psychopathology, and Parental Criminality—Clinical and Epidemiological Findings*, 15 J. AM. ACAD. CHILD PSYCHIATRY 665, 675 (1976) (finding, in a sample of delinquent children, a high rate of parental psychiatric treatment and parental criminality in both their mothers and fathers). Mednick, Gabrielli & Hutchings, *Genetic Factors in the Etiology of Criminal Behavior*, in THE CAUSES OF CRIME, *supra* note 2, at 74 (noting a particularly strong correlation between the chronic conviction records of adoptees and their biological parents); Mednick, Kirkegaard-Sorenson, Hutchings, Knop, Rosenberg & Schulsinger, *An Example of Biosocial Interaction Research: The Interplay of Socioenvironmental and Individual Factors in the Etiology of Criminal Behavior*, in BIOSOCIAL BASES OF CRIMINAL BEHAVIOR, *supra* note 6, at 9, 16 (reporting that 40% of the fathers whose sons were recorded serious criminals were serious criminals themselves). Osborn & West, *Conviction Records of Fathers and Sons Compared*, 19 BRIT. J. CRIMINOLOGY 120, 128 (1979) ("[O]f 35 sons [studied] who had both [a] father and an elder brother convicted, 25 (71.4 per cent.) were delinquents, compared with only six (42.9 per cent.) of the 14 sons with a convicted father but conviction-free elder brothers."); Robins, West & Herjanic, *Arrests and Delinquency in Two Generations: A Study of Black Urban Families and Their Children*, 16 J. CHILD PSYCHOLOGY & PSYCHIATRY & ALLIED DISCIPLINES 125, 130 (1975) (noting that, "while delinquency in both the mother and father is associated with delinquency in their sons, there is a significant increase" in the delinquency rate of sons only when the mother is delinquent); see also Bohman, Cloninger, Sigvardsson & von Knorring, *Predisposition to Petty Criminality in Swedish Adoptees: Genetic and Environmental Heterogeneity*, 39 ARCHIVES GEN. PSYCHIATRY 1233, 1237 (1982) (concluding that criminality characterized by a small number of petty property offenses was partly inherited by adopted-away sons from their biological parents independently of a predisposition to alcohol); Christiansen, *A Review of Studies of Criminality Among Twins*, in BIOSOCIAL BASES OF CRIMINAL BEHAVIOR, *supra* note 6, at 45, 45-88 (reviewing nine studies of twins that suggested correlations between criminal behavior and genetic inheritance and concluding that a dynamic interaction between heredity and environment shapes criminal behavior); Crowe, *An Adoption Study of Antisocial Personality*, 31

relied, for the most part, on family, twin, and adoption studies using the criminal behaviors of biological relatives as proxies for genetic transmission.⁵⁴ Attempts to discern genetic and environmental influences on behavior, however, are methodologically problematic and inconclusive.⁵⁵ Indeed, with some exceptions, the evidence for genetic relationships becomes weaker as research methodologies become more sound.⁵⁶

A major exception is the "largest systematic adoption study of criminality"⁵⁷ yet conducted, which was based on a sample of over 4,000 male adoptees drawn from an original sample of all nonfamilial adoptions in Denmark from 1927 to 1947.⁵⁸ Like previous adoption research,⁵⁹ this study used a "cross-fostering model" that compared distributions of criminality among biological and adopted parents and sons.⁶⁰ The authors reported that the criminality of the biological parents was a more important predictor of adoptees' crimes than the crimi-

ARCHIVES GEN. PSYCHIATRY 785, 790 (1974) ("These findings . . . indicate that heredity plays some role in the development of antisocial personality."); cf. Hutchings & Mednick, *Criminality in Adoptees and Their Adoptive and Biological Parents: A Pilot Study*, in BIOSOCIAL BASES OF CRIMINAL BEHAVIOR, *supra* note 6, at 127, 140 (finding that criminal biological fathers of adopted children were more severely criminal when their biological children were criminal than when they were not); Schulsinger, *Psychopathy: Heredity and Environment*, in BIOSOCIAL BASES OF CRIMINAL BEHAVIOR, *supra* note 6, at 109, 121 (reporting that, in a sample of adopted children diagnosed as psychopathic, biological fathers had psychopathy five times as frequently as adoptive fathers).

⁵⁴ See J. WILSON & R. HERRNSTEIN, *supra* note 1, at 90.

⁵⁵ For a discussion of these issues, see Cloninger, Reich & Guze, *The Multifactorial Model of Disease Transmission: II. Sex Differences in the Familial Transmission of Sociopathy*, 127 BRIT. J. PSYCHIATRY 11, 11-22 (1975); see also J. WILSON & R. HERRNSTEIN, *supra* note 1, at 95 ("Children are put up for adoption at varying ages; couples who adopt children are not a random sample of all couples; adoption agencies often try to match children to their foster parents in various ways; the parent-child relationship may well be deeply conditioned by whether it is adoptive or biological."); Mednick, Gabrielli & Hutchings, *supra* note 53, at 74 (because identical twins are often treated more alike than fraternal twins, there is "a reluctance to accept in full the genetic implications of twin research"); *id.* at 88 (discussing the possible effects of the fact that adopting parents have often been informed about the criminal convictions of their child's biological parents).

⁵⁶ See Detre, Kupfer & Taub, *The Nosology of Violence*, in NEURAL BASES OF VIOLENCE AND AGGRESSION 294, 295 (W. Fields & W. Sweet eds. 1975).

⁵⁷ J. WILSON & R. HERRNSTEIN, *supra* note 1, at 96. Another exception is Rowe, *Genetic and Environmental Components of Antisocial Behavior: A Study of 265 Twin Pairs*, 24 CRIMINOLOGY 513, 513-32 (1986).

⁵⁸ See Mednick, Gabrielli & Hutchings, *Genetic Influences in Criminal Convictions: Evidence from an Adoption Cohort*, 224 SCIENCE 891, 891-94 (1984) [hereinafter Mednick, *Genetic Influences*].

⁵⁹ See, e.g., Hutchings & Mednick, *supra* note 53, at 137 (illustrating the four-way, cross-fostering analysis of criminal father/criminal son, criminal father/noncriminal son, noncriminal father/criminal son, and noncriminal father/noncriminal son).

⁶⁰ See Mednick, *Genetic Influences*, *supra* note 58, at 892.

nality of the adopted parents.⁶¹ Moreover, this association strengthened considerably when the biological parent was chronically criminal.⁶² According to the study's authors, these "findings imply that biological predispositions are involved in the etiology of at least some criminal behavior."⁶³

The authors' conclusions, however, do not emphasize that the study reports associations only for property crimes, but not for crimes of violence.⁶⁴ Moreover, environmental factors and mental or behavioral disorders among parents or family members may increase, or perhaps mitigate, the risk of criminality among offspring. For example, a statistically significant relationship has been found between male adoptee criminality and the length of time the adoptee spent in an orphanage waiting to be adopted.⁶⁵ Mother's schizophrenia, alone⁶⁶ or in interaction with father's criminality,⁶⁷ and the delinquency of siblings⁶⁸ have also been found to be influential in the potential criminality of subjects in family studies.

Two other factors warrant emphasis. First, most studies have not focused on the possible genetic transmission of violent, or high risk, criminality. Those studies that have looked at violence⁶⁹ confirm the conclusion of one research review that "the evidence does not support a role for genetic factors in the etiology of violence."⁷⁰ Second, a disproportionate number of the largest adoption studies on criminality have

⁶¹ See *id.* The adoptees had 13.5% conviction rate when neither adoptive nor biological parents had been convicted, a 14.7% conviction rate when only the adoptive parents had been convicted, and a 20% conviction rate when only the biological parents had been convicted. See *id.*

⁶² See *id.* at 892-93.

⁶³ *Id.* at 893.

⁶⁴ See *id.* at 892.

⁶⁵ See *id.* at 894 n.11.

⁶⁶ See J. COLEMAN, J. BUTCHER & R. CARSON, *ABNORMAL PSYCHOLOGY AND MODERN LIFE* 419 (6th ed. 1980).

⁶⁷ See Kirkegaard-Sorensen & Mednick, *A Prospective Study of Predictors of Criminality: 2. A Description of Registered Criminality in the High-Risk and Low-Risk Families*, in *BIOSOCIAL BASES OF CRIMINAL BEHAVIOR*, *supra* note 6, at 229, 235-37.

⁶⁸ See, e.g., Osborn & West, *supra* note 53, at 128 ("Among the 42 sons of unconvicted fathers who had an elder brother with a conviction record, 15 (35.7 per cent.) were delinquents."); Robins, West & Herjanic, *supra* note 53, at 136 ("In both small and large families, having a delinquent sibling was associated with being delinquent oneself.").

⁶⁹ See, e.g., *Biology and Violence*, *supra* note 1, at 28 (concluding that the slight tendency for violence in adoptees to correspond to convictions of their biological parents is statistically insignificant); Osborn & West, *supra* note 53, at 127 ("There was no evidence that fathers convicted for crimes of violence were particularly likely to have sons similarly convicted.").

⁷⁰ *Biology and Violence*, *supra* note 1, at 28.

been conducted in Denmark, a relatively culturally homogenous nation that "permits better expression of existing genetic tendencies in individuals living in that environment."⁷¹ Thus, further research showing links with violence in a number of different environments would be needed to support a convincing argument for the familial transmission of criminality, whether violent or not.

Alternative arguments can be made, however, that regardless of the methodological flaws in family studies, genetic factors are the key to the transmission of certain characteristics, such as hormonal and physiological make-up, across different subgroups of criminals. Most obvious are the marked differences in patterns of violence and aggression between males and females that can be largely explained by hormonal variations existing throughout life.

B. *Hormonal Research*

Substantial evidence indicates that males are generally more aggressive than females⁷² even before preschool years.⁷³ Researchers have linked these gender differences in behavior to genetic, hormonal, and social learning effects.⁷⁴

Evidence of an association between androgen levels and aggression in human males, however, is complex and inconclusive. Moreover, it is possible that relationships between hormone level and behavior can take different forms. For example, some research suggests that hormone levels may influence behavior indirectly through their effect on cognitive structure during prenatal and early adolescent development,⁷⁵ such

⁷¹ See Mednick, Gabrielli & Hutchings, *supra* note 53, at 89.

⁷² See G. SIANN, ACCOUNTING FOR AGGRESSION: PERSPECTIVES ON AGGRESSION AND VIOLENCE 33-37 (1985).

⁷³ See Maccoby & Jacklin, *Sex Differences in Aggression: A Rejoinder & Reprise*, 51 CHILD DEV. 964, 964-80 (1980).

⁷⁴ See K. HOYENGA & K. HOYENGA, THE QUESTION OF SEX DIFFERENCES: PSYCHOLOGICAL, CULTURAL, AND BIOLOGICAL ISSUES 6-10 (1979).

⁷⁵ For example, some research suggests a link between particular hormone levels and later cognitive, psychological, and behavioral variations. Associations between early gonadal hormones and later behavior—particularly aggression—have been examined extensively in animals, but less so in humans. See Reinisch, *Prenatal Exposure to Synthetic Progestins Increases Potential for Aggression in Humans*, 211 SCIENCE 1171, 1171-73 (1981). In one of the few studies on human subjects, Reinisch found that prenatal exposure to synthetic progestins, which have been shown to have an androgenic potential, was significantly related to verbal estimates of aggressive response among both males and females. See *id.* at 1172. Neither the age (a range of six to eighteen years) nor the birth order of the subjects or their sibling controls were related to aggression scores. See *id.* These findings are consistent with a few previous reports, see *id.* at 1172-73 (reviewing such reports), and with observations of excess "tomboyism" and more masculine identification among prenatally exposed females, see Ehrhardt & Money, *Progesterin-Induced Hermaphroditism: IQ and Psychosexual Iden-*

as the degree of lateralization of the cerebral cortex.⁷⁶

In general, however, the behavioral traits of dominance and aggression in the human male have been associated more directly with levels or rates of testosterone production.⁷⁷ Evidence also suggests that these rates are linked to age. In an examination of two groups of age-differentiated men, the average testosterone production rate of older men (thirty-one to sixty-six years) was half that of younger men (seventeen to twenty-eight years).⁷⁸ This outcome has been compared in the aggregate with the disproportionately high violent crime rate among males between the ages of fifteen and twenty-four in the United States.⁷⁹

Research on more direct associations between androgen levels, primarily testosterone, and criminality shows somewhat conflicting results,⁸⁰ possibly because of the different types of hormone measures used,⁸¹ prison environment, or types of offenders examined. In their

tity in a Study of 10 Girls, 3 J. SEX RES. 83, 93 (1967). However, this evidence is limited and suggestive only. For other interpretations, see G. SIANN, *supra* note 72, at 34-36.

⁷⁶ Evidence of anatomic and functional differences in the lateralization of the two (left and right) cerebral hemispheres provides one explanation for both cognitive and behavioral variations in the general population. "Lateralization" refers to the "localization of a psychological function in a single hemisphere." Burstein, Bank & Jarvik, *Sex Differences in Cognitive Functioning: Evidence, Determinants, Implications*, 23 HUMAN DEV. 289, 304 (1980). Individuals who are more lateralized tend to show greater hemispheric specialization in processing information compared to less lateralized individuals. See *id.* at 304-06; see also *infra* note 149 and accompanying text (discussing the link between cerebral lateralization and crime).

⁷⁷ See Moyer, *Physiological Determinants of Human Aggression*, in COLLOQUIUM ON THE CORRELATES OF CRIME AND THE DETERMINANTS OF CRIMINAL BEHAVIOR 175, 185-87 (L. Otten ed. 1978) [hereinafter Moyer, *Physiological Determinants*] (prepared by The MITRE Corporation); Shah & Roth, *supra* note 24, at 123.

⁷⁸ See Persky, Smith & Basu, *Relation of Psychologic Measures of Aggression and Hostility to Testosterone Production in Men*, 33 PSYCHOSOMATIC MED. 265, 267 (1971).

⁷⁹ See Moyer, *Physiological Determinants*, *supra* note 77, at 185.

⁸⁰ See Olweus, *Testosterone and Adrenaline: Aggressive Antisocial Behavior in Normal Adolescent Males*, in THE CAUSES OF CRIME, *supra* note 2, at 263; see also K. MOYER, VIOLENCE AND AGGRESSION 43-44 (1987) [hereinafter K. MOYER, VIOLENCE] (discussing a study of prisoners that showed no relationship between blood testosterone levels and aggression).

⁸¹ Failure to find differences among the less violent offenders, in particular, may be attributed, in part, to the types of hormone measures used. For example, Lloyd and Weisz reported no significant differences between prisoners and other men in concentrations of testosterone in plasma (which fluctuate considerably); in a presumably more valid measure of androgen level, however, prisoners excreted significantly more testosterone over 24 hours than normal men. See Lloyd & Weisz, *Hormones and Aggression*, in NEURAL BASES OF VIOLENCE AND AGGRESSION, *supra* note 56, at 92, 105-108. More recently, researchers have found that circulating luteinizing hormone levels, which appear to be associated with sexual arousal, are significantly higher in men during violent behavior than during nonviolent behavior. See Mendelson, Dietz & El-

examination of aggression in a sample of young males, Kreuz and Rose found no differences in plasma testosterone levels between groups of nonoffenders and prisoners,⁸² although they found that prisoners with histories of more violent crimes in adolescence had significantly higher levels of testosterone than prisoners without violent histories.⁸³ Imprisoned rapists and child molesters in another study also did not differ significantly from normal men in testosterone level, although, when examined individually, the most violent rapists had significantly higher levels than the other subjects.⁸⁴ Moreover, recent research on a sample of fifteen to seventeen year old boys showed a "substantial correlation" between testosterone level and self-reports of both verbal and physical aggression.⁸⁵

Research on the association between testosterone level and human female behavior is scarce. In one isolated study, significantly higher testosterone levels were found among violent female outpatients than among the nonviolent ones, whose levels were similar to those reported for normal females.⁸⁶ This study reported increased irritability among violent patients during menstruation,⁸⁷ which is consistent with other research showing associations between criminality and both premenstrual and menstrual periods.⁸⁸

According to Dalton, who has conducted the most research in this

lingboe, *Postmortem Plasma Luteinizing Hormone Levels and Antemortem Violence*, 17 PHARMACOLOGY: BIOCHEMISTRY & BEHAV. 171, 172 (1982).

⁸² See Kreuz & Rose, *Assessment of Aggressive Behavior and Plasma Testosterone in a Young Criminal Population*, 34 PSYCHOSOMATIC MED. 321, 327-28 (1972).

⁸³ See *id.* at 327.

⁸⁴ See Rada, Laws & Kellner, *Plasma Testosterone Levels in the Rapist*, 38 PSYCHOSOMATIC MED. 257, 263, 265 (1976); see also Bain, Langevin, Dickey & Ben-Aron, *Sex Hormones in Murderers and Assaulters*, 5 BEHAVIORAL SCI. & L. 95, 98-100 (1987) (failing to find any demonstrable differences in hormone levels among murderers, assaulters, and a control group, but noting that the study was not definitive).

⁸⁵ See Olweus, *supra* note 80, at 264-65.

⁸⁶ See Ehlers, Rickler & Hovey, *A Possible Relationship Between Plasma Testosterone and Aggressive Behavior in a Female Outpatient Population*, in LIMBIC EPILEPSY AND THE DYSCONTROL SYNDROME 183, 191 (M. Girgis & L. Kiloh eds. 1980).

⁸⁷ See *id.* at 190-91.

⁸⁸ For differing conclusions based upon reviews of research on menstruation and crime, see K. MOYER, *VIOLENCE*, *supra* note 80, at 49-53 (reviewing evidence of the link between crime and PMS, but noting that the underlying physiology is obscure); L. TAYLOR, *supra* note 5, at 93 (concluding that "the syndrome is increasingly being isolated as a primary factor in the incidence of criminal behavior among women"); Harry & Balcer, *Menstruation and Crime: A Critical Review of the Literature from the Clinical Criminology Perspective*, 5 BEHAVIORAL SCI. & L. 307 (1987) (arguing that there is insufficient evidence to know whether there is a link between any phase of the menstrual cycle and crime); Horney, *Menstrual Cycles and Criminal Responsibility*, 2 L. & HUM. BEHAV. 25, 29-33 (1978) (raising several critical questions regarding interpretations of research on menstruation and crime).

area,⁸⁹ the symptoms of premenstrual syndrome (PMS)⁹⁰ vary considerably, although they can include increased aggression, hostility, irritability, headaches, edema, psychiatric symptoms, and suicide attempts.⁹¹ There is some consensus that the symptoms are attributed to "a fall in the progesterone level and a relatively greater amount of estrogen in the estrogen-progesterone ratio."⁹² Recent reviews indicate, however, that "there is an extremely limited and somewhat inconsistent understanding of the relationship between menstrual symptoms, behavior, and endocrine fluctuations."⁹³ Moreover, PMS-crime research is fraught with serious methodological difficulties, including variations in measures of cycle duration, post-hoc correlations that incorrectly imply causation, use of retrospective self-report data, anecdotal methods, small samples, and lack of appropriate control samples or controls for external influences, such as stress.⁹⁴ Such difficulties make clear that PMS-crime research to date in no way warrants the conclusion drawn by at least one legal commentator that "[t]here appears to be a *direct correlation* between the premenstrual syndrome and the incidence of criminal behavior."⁹⁵ PMS-crime research must show greater reliability and validity before further conclusions can be made.

Other biochemical factors besides hormone levels have also been linked to aggressive or criminal behaviors. These factors include diet and hypoglycemia (a sudden drop in blood sugar),⁹⁶ the effects of stress

⁸⁹ Some of Dalton's key publications include: K. DALTON, *THE PREMENSTRUAL SYNDROME* (1964); Dalton, *Menstruation and Crime*, 2 BRIT. MED. J. 1752 (1961); Dalton, *Menstruation and Examinations*, [1968] 2 LANCET 1386; Dalton, *Cyclical Criminal Acts in Premenstrual Syndrome*, [1980] 2 LANCET 1070.

⁹⁰ PMS has been defined as "the recurrence of symptoms in the premenstruum [premenstruation period] with absence of symptoms in the postmenstruum." K. DALTON, *THE PREMENSTRUAL SYNDROME AND PROGESTERONE THERAPY* 3 (2d ed. 1984). The premenstrual syndrome should be distinguished from incidences of "menstrual distress," which Dalton defines as "the presence of intermittent or continuous symptoms present *throughout* the menstrual cycle which increase in severity during the premenstruum or menstruation." *Id.* at 6.

⁹¹ See K. MOYER, *VIOLENCE*, *supra* note 80, at 49-50.

⁹² *Id.* at 50-52.

⁹³ Harry & Balcer, *supra* note 88, at 317; see also G. SIANN, *supra* note 72, at 38 (noting that "[w]hether or not this syndrome is directly associated with hormonal changes has not been established").

⁹⁴ See Harry & Balcer, *supra* note 88, at 313-17.

⁹⁵ L. TAYLOR, *supra* note 5, at 88.

⁹⁶ See Geary, *Nutrition, Chemicals and Criminal Behavior: Some Physiological Aspects of Anti-Social Conduct*, 34 JUV. & FAM. CT. J. 9, 9-10 (1983) (presenting case histories and research evidence of the link between diet, the brain, and criminal behavior); Hippchen, *The Need for a New Approach to the Delinquent-Criminal Problem*, in *ECOLOGIC-BIOCHEMICAL APPROACHES TO TREATMENT OF DELINQUENTS AND CRIMINALS* 3, 13 (L. Hippchen ed. 1978) [hereinafter *ECOLOGIC-BIOCHEMICAL APPROACHES*] ("Four major groups of symptoms may accompany biochemical deficiencies or abnormalities in the body, and may be seen as 'antisocial': (1) perceptual

on hormonal and neural system levels,⁹⁷ allergens,⁹⁸ and the use of

changes due to nutritional disorders; . . . (3) hyperactivity due to nutritional deficiencies; and (4) hyperactivity due to hypoglycemia.”); Hoffer, *Some Theoretical Principles Basic to Orthomolecular Psychiatric Treatment*, in *ECOLOGIC-BIOCHEMICAL APPROACHES*, *supra*, at 31, 46 (noting a growing consensus among scientists that foods have a major impact on behavior); Lerner, *The Nutrition-Juvenile Delinquency Connection*, *MED. SELF-CARE*, Summer 1982, at 21, 22-24 (discussing five nutritional factors that affect behavior and, thus, delinquency: hypoglycemia, food additives, junk food, food and chemical sensitivities, and nutritional supplementation); Podolsky, *The Chemical Brew of Criminal Behavior*, 45 *J. CRIM. L. CRIMINOLOGY & POLICE SCI.* 675, 675 (1955) (arguing that “there is an intimate relationship between the amount of sugar present in the blood and men’s social behavior”); Rimland & Larson, *Nutritional and Ecological Approaches to the Reduction of Criminality, Delinquency and Violence*, 33 *J. APPLIED NUTRITION* 116, 119 (1981) (stating that the brain is a “soggy computer,” the functioning of which depends on diet, because diet affects what is dissolved in the liquid through which connections are made); Schauss & Simonsen, *A Critical Analysis of the Diets of Chronic Juvenile Offenders, Part I*, 8 *J. ORTHOMOLECULAR PSYCHIATRY* 149, 155 (1979) (reporting that a preliminary study indicates that there are significant differences between the diets of chronic juvenile offenders and non-offenders); Shah & Roth, *supra* note 24, at 125-26 (accepting that “it is possible that law-violating and aggressive behaviors have an increased probability of occurring during . . . episodes” of hypoglycemia).

The diet-crime link is further supported by evidence of a more general connection between diet and behavior. *See, e.g.*, B. FEINGOLD, *WHY YOUR CHILD IS HYPERACTIVE* (1975) (discussing the effects of diet on early childhood hyperactivity and behavioral difficulty); D’Asaro, Groesbeck & Nigro, *Diet-Vitamin Program for Jail Inmates*, 4 *J. ORTHOMOLECULAR PSYCHIATRY* 212, 217-19 (1975) (reporting a high success rate in reducing behavioral disorders with a controlled diet and vitamin supplements); Elliott, *Neurological Factors*, in *HANDBOOK OF FAMILY VIOLENCE* 359, 373 (V. Van Hasselt, R. Morrison, E. Bellack & M. Hersen eds. 1988) [hereinafter Elliot, *Neurological Factors*] (including hypoglycemia in a list of metabolic disorders that affect human behavior); Green, *Treatment of Penitentiary Inmates*, in *ECOLOGIC-BIOCHEMICAL APPROACHES*, *supra*, at 269, 278 (linking physical problems “to the excessive use of flour, sugar, and starch”); Pauling, *Orthomolecular Psychiatry*, 160 *SCIENCE* 265, 265 (1968) (defining “orthomolecular psychiatric therapy [a]s the treatment of mental disease by the provision of the optimum molecular environment for the mind,” which is often accomplished by dieting and controlling the concentration of substances present in the body); *cf.* Abrams, Schultz, Margen & Ogar, *Perspectives in Clinical Research: A Review of Research Controversies Surrounding the Feingold Diet*, 1 *FAM. & COMMUNITY HEALTH* 93, 102-109 (1979) (examining certain methodological problems with testing the link between diet and behavior); Bonnet & Pfeiffer, *Biochemical Diagnosis for Delinquent Behavior*, in *ECOLOGIC-BIOCHEMICAL APPROACHES*, *supra*, at 183, 183-205 (suggesting various diagnostic methods to evaluate and treat biochemical disorders).

⁹⁷ *See* Moyer, *Physiological Determinants*, *supra* note 77, at 187 (“[F]rustration and stress are important variables in inducing aggressive behavior . . . because the stressors change the hormonal status and thus change the thresholds for the neural systems for aggression.”); Woodman, Hinton & O’Neill, *Plasma Catecholamines, Stress and Aggression in Maximum Security Patients*, 6 *BIOLOGICAL PSYCHOLOGY* 147, 153 (1978) (reporting that individuals who secrete relatively high levels of adrenaline tended to have committed more violent crime).

⁹⁸ *See* Wunderlich, *Neuroallergy as a Contributing Factor to Social Misfits: Diagnosis and Treatment*, in *ECOLOGIC-BIOCHEMICAL APPROACHES*, *supra* note 96, at 229, 230 (recognizing “the potentially devastating effect of neuroallergy on one’s interpersonal transactions and social adjustments”).

drugs⁹⁹ and alcohol.¹⁰⁰ Direct associations between these factors and

⁹⁹ See H. HARWOOD, D. NAPOLITANO, P. KRISTIANSEN & J. COLLINS, ECONOMIC COSTS TO SOCIETY OF ALCOHOL AND DRUG ABUSE AND MENTAL ILLNESS: 1980, at 56 table III-12 (1984) (published by the Research Triangle Institute) (estimating that 10% of the homicides nationwide are the result of drug abuse); B. JOHNSON, P. GOLDSTEIN, E. PREBLE, J. SCHMEIDLER, D. LIPTON, B. SPUNT & T. MILLER, TAKING CARE OF BUSINESS: THE ECONOMICS OF CRIME BY HEROIN ABUSERS 27-34 (1985) (reporting that frequency of heroin use is correlated with both seriousness and frequency of criminal activity); Goldstein, *The Drugs/Violence Nexus: A Tripartite Conceptual Framework*, 15 J. DRUG ISSUES 493, 494 (1985) (suggesting that drugs and violence are related to each other in three different ways: psychopharmacologically, economically compulsively, and systematically); Goldstein, Hunt, Des Jarlais & Deren, *Drug Dependence and Abuse*, in CLOSING THE GAP: THE BURDEN OF UNNECESSARY ILLNESS 89, 90, 95-96 (R. Amler & H. Dull eds. 1987) (estimating that in the United States in 1980 over 2,000 homicides were drug-related and, assuming an average life span of 65 years, resulted in the loss of close to 70,000 years of life); Graham, *Controlling Drug Abuse and Crime: A Research Update*, NIJ REPORTS, Mar.-Apr. 1987, at 2, 2-3 (listing various studies suggesting that drug use by arrested persons is on the rise, including a New York study that found that 80% of those arrested in September and October of 1986 tested positive for cocaine); Simonds & Kashani, *Specific Drug Use and Violence in Delinquent Boys*, 7 AM. J. DRUG & ALCOHOL ABUSE 305, 308 (1980) (noting in a study of institutionalized delinquent boys that about 43% took a drug within 24 hours of committing an offense against a person); Anglin, Book Review, 45 J. STUD. ALCOHOL 469, 469 (1984) (concluding that "the relationship between drug use and violence can best be viewed as a probabilistic and relativistic function in which the violent outcome is dependent on the interaction of a host of biological, sociocultural and psychological factors"). See generally D. ELLIOTT, D. HUIZINGA & S. AGETON, EXPLAINING DELINQUENCY AND DRUG USE 11 (1985) (presenting "an integrated theoretical perspective on delinquency and drug use").

Interestingly, alcohol and drug use is also common among victims of crime. See Felson & Steadman, *Situational Factors in Disputes Leading to Criminal Violence*, 21 CRIMINOLOGY 59, 65, 72 (1983) (finding in a New York study that homicide victims were significantly more likely than assault victims to have used alcohol or drugs); Zahn & Bencivengo, *Violent Death: A Comparison Between Drug Users and Nondrug Users*, 1 ADDICTIVE DISEASES 283, 283-96 (1974) (reporting that in Philadelphia in 1972, homicide was the leading cause of death among drug users).

¹⁰⁰ See Collins, *The Relationship of Problem Drinking to Individual Offending Sequences*, in 2 CRIMINAL CAREERS AND "CAREER CRIMINALS" 89, 105 (A. Blumstein, J. Cohen, J. Roth & C. Visher eds. 1986) (concluding after a review of five studies that prisoners with drinking problems have higher assault rates than prisoners without drinking problems); Lindqvist, *Criminal Homicide in Northern Sweden 1970-1981: Alcohol Intoxication, Alcohol Abuse and Mental Disease*, 8 INT'L J.L. & PSYCHIATRY 19, 22-26 (1986) (finding that two-thirds of the offenders and 45% of the victims in his study were intoxicated at the time of the crime and that homicides involving a stabbing or cutting were highly associated with the presence of alcohol in the offender); Welte & Miller, *Alcohol Use by Violent and Property Offenders*, 19 DRUG & ALCOHOL DEPENDENCE 313, 323 (1987) (suggesting that acute drinking effects are more instrumental in the commission of violence by some individuals than are chronic effects); see also Coleman & Strauss, *Alcohol Abuse and Family Violence*, in ALCOHOL, DRUG ABUSE, AND AGGRESSION 104, 108-09 (E. Gottheil, K. Druley, T. Skoloda & H. Waxman eds. 1983) (suggesting that wife-beaters may use alcohol to deflect responsibility for their behavior); McCaghy, *Drinking and Deviance Disavowal: The Case of Child Molesters*, 16 SOC. PROBS. 43, 48 (1968) (showing that sex offenders may use alcohol as an excuse to avoid responsibility for their behavior); Mandiberg, *Protecting Society and Defendants Too: The Constitutional Dilemma of Mental Ab-*

hormone levels have also been noted.¹⁰¹ Once again, however, because research on some of these factors is statistically weak and unscientific, more carefully performed studies are needed.

Whether or not hormonal disorders should provide a criminal law defense is a different issue. For example, although PMS distress has been used successfully as a defense in England,¹⁰² *People v. Santos*¹⁰³ is the unusual criminal case that has raised this defense in the United States. In *Santos*, the defendant faced a charge of first degree assault against her infant daughter.¹⁰⁴ The defendant herself, however, resisted the use of the PMS defense, and, because the case ended in a plea bargain, the court never fully evaluated the merits of a PMS defense.¹⁰⁵

As yet, the PMS defense has no United States precedent, although the symptoms have been discussed in a few civil cases.¹⁰⁶ Despite some arguments in the legal community supporting the defense,¹⁰⁷ many le-

normality and Intoxication Defenses, 53 *FORDHAM L. REV.* 221, 227 n.33 (1984) (explaining that "a high level of intoxication can prevent subjective awareness of external reality"); Pernanen, *Theoretical Aspects of the Relationship Between Alcohol Use and Crime*, in *DRINKING AND CRIME: PERSPECTIVES ON THE RELATIONSHIP BETWEEN ALCOHOL CONSUMPTION AND CRIMINAL BEHAVIOR* 2, 64 (J. Collins ed. 1981) [hereinafter *DRINKING AND CRIME*] (citing evidence of impaired cognitive capability and judgment resulting from drinking). *But see* J. PETERSILIA, P. GREENWOOD & M. LAVIN, *CRIMINAL CAREERS OF HABITUAL FELONS* 84-85 (1977) (hypothesizing that alcohol users are more likely to be arrested than drug users or nonusers, which the authors conclude overstates the role of alcohol use); Hamilton & Collins, *The Role of Alcohol in Wife Beating and Child Abuse: A Review of the Literature*, in *DRINKING AND CRIME*, *supra*, at 253, 261 (noting the tendency to blame alcohol as a link to violence in terms of its negative moral status). *See generally* W. LAFAVE & A. SCOTT, 1 *SUBSTANTIVE CRIMINAL LAW* 549-65 (1986) (reviewing the legal literature establishing intoxication as one element in a defense to criminal charges); Goodwin, *Family and Adoption Studies of Alcoholism*, in *BIOSOCIAL BASES OF CRIMINAL BEHAVIOR*, *supra* note 6, at 143, 157 (concluding that alcoholism runs in the family); Goodwin, Schulsinger, Hermansen, Guze & Winokur, *Alcohol Problems in Adoptees Raised Apart from Alcoholic Biological Parents*, 28 *ARCHIVES GEN. PSYCHIATRY* 238, 242 (1973) (finding that the sons of alcoholics who had been adopted at an early age were considerably more likely to become adult alcoholics than were the adopted sons of nonalcoholics).

¹⁰¹ *See* Moyer, *Physiological Determinants*, *supra* note 77, at 185-89 (1978).

¹⁰² *See* Comment, *Premenstrual Syndrome as a Criminal Defense: The Need for a Medico-Legal Understanding*, 15 *N.C. CENT. L.J.* 246, 246 (1985) [hereinafter Comment, *Premenstrual Syndrome*].

¹⁰³ No. 1KO46299 (Kings County, N.Y. Crim. Ct. Nov. 3, 1982), *discussed in* Comment, *Premenstrual Syndrome*, *supra* note 102, at 256.

¹⁰⁴ *See* Comment, *Premenstrual Syndrome*, *supra* note 102, at 256.

¹⁰⁵ *See id.* at 257.

¹⁰⁶ *See id.* at 257-58 & n.98 (citing *Hoffman-LaRoche v. Kleindiest*, 478 F.2d 1, 9 (3d Cir. 1973); *Crockett v. Cohen*, 299 F. Supp. 739, 731 (W.D. Va. 1969); *Reid v. Florida Real Estate Comm'n*, 188 So. 2d 846, 849 (Fla. Dist. Ct. App. 1966); *Tingen v. Tingen*, 251 Or. 458, 460, 446 P.2d 185, 186 (1968)).

¹⁰⁷ *See, e.g., id.* at 257 (quoting the judge in *Santos* as saying that "since psychological disturbances are admissible as evidence relating to criminal intent, physiological disturbances, such as PMS, might likewise be admitted"); *see also* Note, *Battered*

gal scholars and practitioners oppose its use because of the questionable links between PMS and behavior.¹⁰⁸ Given the success of the defense of postpartum illness in Ann Green's murder trial,¹⁰⁹ these perspectives may change.

Weak or inconsistent associations found in psychophysiological research on criminality¹¹⁰ may explain the dearth of cases in which a psychophysiological defense to violent behavior has been attempted. In a limited number of cases, however, evidence that focuses more directly on mental functioning appears to be somewhat more convincing to judges and juries. The following Sections briefly examine recent research on neurophysiological and intellectual capacities and selected cases in which such data have been proffered as a defense to criminal behavior.

C. Neurophysiological Studies

For the most part, neurophysiological studies of delinquency and crime have relied on electroencephalographic (EEG) assessments of

Woman's Syndrome and Premenstrual Syndrome: A Comparison of Their Possible Use as Defenses to Criminal Liability, 59 ST. JOHN'S L. REV. 558, 583-84 (1985) (arguing that the level of scientific knowledge about PMS justifies legal recognition of the syndrome).

¹⁰⁸ See, e.g., Holtzman, *Premenstrual Symptoms: No Legal Defense*, 60 ST. JOHN'S L. REV. 712, 713 (1986) (stating that "there is no scientific evidence for the proposition that the onset of the menstrual cycle provokes aggressive or violent behavior in women"); Chambers, *Menstrual Stresses as a Legal Defense*, N.Y. Times, May 29, 1982, at 46, col. 5 (reporting Prof. H. Richard Uviller's criticism of the PMS defense as degrading to women).

¹⁰⁹ See *supra* notes 13-15 and accompanying text.

¹¹⁰ Psychophysiological research on criminality has focused very generally on the relationships between varying degrees, types, and timing of the arousal of autonomic nervous system indicators and the subsequent conditionability of behavior. Cognizance of these relationships stems from early studies by Lykken, who reported that a control group of non-imprisoned normal individuals with no history of mental disorder showed a relatively stronger ability in avoidance-learning situations than psychopaths or sociopaths, who showed a weaker learning ability. See Lykken, *A Study of Anxiety in the Sociopathic Personality*, 55 J. ABNORMAL & SOC. PSYCHOLOGY 6, 9 (1957). Later research suggested that criminals may have some deficiency of avoidance-learning ability that impairs the inhibition of antisocial responses. Research trends indicate the possibility of a constitutional indisposition to avoidance-learning ability, particularly a lack of a fear response to aversive stimuli. See Hinton, O'Neill, Hamilton & Burke, *Psychophysiological Differentiation Between Psychopathic and Schizophrenic Abnormal Offenders*, 19 BRIT. J. SOC. & CLINICAL PSYCHOLOGY 257, 266-67 (1980) (contrasting the extensive fear responses of schizophrenics with the relative lack of anticipatory fears on the part of psychopaths and speculating that the difference is attributable to varying levels of cortical activity); Venables, *Autonomic Nervous System Factors in Criminal Behavior*, in THE CAUSES OF CRIME, *supra* note 2, at 110, 132 (suggesting that several studies indicate that "psychopaths are less capable of experiencing fear" because of "an excess of vagal tone").

brain functioning. EEGs record the minute electrical oscillations (brain waves) emitted by the cerebral cortex. Four major categories of brain waves are identified according to the frequency (number of cycles per second) and amplitude of the wave: alpha, beta, delta, and theta rhythms. The prevalence of a given wave pattern appears to be related to different areas and functions of the brain.¹¹¹

Traditionally, EEGs have been evaluated by an electroencephalographer, who rates patterns according to their appearance. These evaluations have been most useful in diagnosing epilepsy. Increasingly, however, EEG records have been analyzed quantitatively by computers, which provide objective, numerical results for detecting a number of different disturbances or processes.¹¹²

Since the 1940s, numerous studies of EEG patterns among delinquents and criminals have been conducted. Qualitative evaluations of EEGs provide the basis for the great majority of these studies, and most of these studies have severe methodological problems.¹¹³ Some research, however, does show consistent, general evidence that a disproportionate number of offenders have EEG abnormalities when compared to the general population. The prevalence of EEG abnormalities appears to

¹¹¹ See *Biology and Violence*, *supra* note 1, at 46.

¹¹² See, e.g., Gevins, Schaffer, Doyle, Cutillo, Tannehill & Bressler, *Shadows of Thought: Shifting Lateralization of Human Brain Electrical Patterns During Brief Visuomotor Task*, 220 SCIENCE 97, 97-99 (1983) [hereinafter Gevins & Schaffer] (reporting research in which computer technology was employed to observe the spatial patterns and sequencing of neurocognitive activity).

¹¹³ For example, differences exist in EEG techniques, interpretations, and the criteria used to define EEG abnormalities. See Ellingson, *The Incidence of EEG Abnormality Among Patients with Mental Disorders of Apparently Nonorganic Origin: A Critical Review*, 111 AM. J. PSYCHIATRY 263, 263 (1954) (stating that "many published studies leave much to be desired in the way of experimental design"); Loomis, Bohnert & Huncke, *Prediction of EEG Abnormalities in Adolescent Delinquents*, 17 ARCHIVES GEN. PSYCHIATRY 494, 496, 497 (1967) (finding no significant relationship between EEG abnormalities and general continuing delinquent behavior and concluding that previous research had apparently overemphasized the role of organic factors in causing delinquent behavior); Shah & Roth, *supra* note 24, at 120 (attributing the diverse results of studies to variable EEG techniques, different definitions of criminal behavior, variations in interpreting EEG patterns, and correction or lack of correction for age). Most studies lack controls for influential effects like sex and age. Age controls are particularly important because EEG patterns vary considerably during development. See Wiener, Delano & Klass, *An EEG Study of Delinquent and Nondelinquent Adolescents*, 15 ARCHIVES GEN. PSYCHIATRY 144, 144 (1966). Many studies have not used statistical techniques to assess the significance of observed group differences. See Ellingson, *supra*, at 264. Many also lack double-blind procedures for evaluating data, as shown by the absence of any mention of the procedure in the studies' methodology description. See Blackburn, *Aggression and the EEG: A Quantitative Analysis*, 84 J. ABNORMAL PSYCHOLOGY 358, 360 (1975); Ellingson, *supra*, at 264; Shah & Roth, *supra* note 24, at 120. These difficulties have contributed to the considerable difficulty in concluding specific findings from EEG research. See Shah & Roth, *supra* note 24, at 120.

be highest among the more violent habitual offenders. For example, half of the murderers in one early study¹¹⁴ and seventy percent of the murderers in another¹¹⁵ evidenced EEG abnormalities. In a later study using control groups and blind examiners, the incidence of EEG abnormalities among murderers was four times greater (sixty-five percent) than in the control group and even higher among psychotic prisoners.¹¹⁶ Other research has reported abnormal EEGs in over seventy percent of incarcerated murderers whose crimes appear to be motiveless.¹¹⁷

Some research has also shown a high number of abnormalities in samples of violent offenders not limited to murderers,¹¹⁸ although studies that identify more specific subgroups of offenders show that this prevalence appears to be highest among the more habitual or psychopathic offenders.¹¹⁹ Other studies have not found disproportionately

¹¹⁴ See Hill & Pond, *Reflections on One Hundred Capital Cases Submitted to Electroencephalography*, 98 J. MENTAL SCI. 23, 26 (1952).

¹¹⁵ See Stafford-Clark & Taylor, *Clinical and Electro-encephalographic Studies of Prisoners Charged with Murder*, 12 J. NEUROLOGY, NEUROSURGERY & PSYCHIATRY 325, 330 (1949).

¹¹⁶ See Sayed, Lewis & Brittain, *An Electroencephalographic and Psychiatric Study of Thirty-Two Insane Murderers*, 115 BRIT. J. PSYCHIATRY 1115, 1123 (1969).

¹¹⁷ See Okasha, Sadek & Moneim, *Psychosocial and Electroencephalographic Studies of Egyptian Murderers*, 126 BRIT. J. PSYCHIATRY 34, 39 (1975).

¹¹⁸ In two separate studies, approximately 50% and 60%, respectively, of the examined individuals with explosive violent behavior or rage had EEG abnormalities. See Bach-y-Rita, Lion, Climent & Ervin, *Episodic Dyscontrol: A Study of 130 Violent Patients*, 127 AM. J. PSYCHIATRY 1473, 1476 (1971); Elliott, *Neurological Findings in Adult Minimal Brain Dysfunction and the Dyscontrol Syndrome*, 170 J. NERVOUS & MENTAL DISEASE 680, 685 (1982) [hereinafter Elliott, *Neurological Findings*]. One-third of the serious offenders examined in two other research studies had EEG deviations. See V. MARK & F. ERVIN, *supra* note 8, at 131, 137; Small, *The Organic Dimension of Crime*, 15 ARCHIVES GEN. PSYCHIATRY 82, 84, 88 (1966). Among relatively severe delinquent inmates observed in Israel, 62.5% had abnormal EEGs, with a disproportionate number of these in the early age groups: 10 to 12 years old. See Asael, Kohen-Raz & Alpern, *Developmental Analysis of EEG Abnormalities in Juvenile Delinquents*, 28 DISEASES NERVOUS SYS. 49, 50 (1967).

¹¹⁹ For example, 48% of the psychopaths and 65% of the aggressive psychopaths examined in one study had EEG abnormalities, while incidences no higher than normal were found among a sample of delinquents without psychopathy or aggression. See Hill & Watterson, *Electro-encephalographic Studies of Psychopathic Personalities*, 5 J. NEUROLOGY & PSYCHIATRY 47, 53, 55 (1942). A review and critique of a number of early studies on EEGs showed that, compared to different groups of individuals with mental and behavioral disorders, aggressive psychopaths consistently had the highest overall incidence (50%) of EEG abnormalities. See Ellingson, *supra* note 113, at 268, 271. A more recent investigation of a random sample of 333 subjects referred for an EEG confirmed earlier findings. Overall, subjects with backgrounds of habitual violence showed an incidence of EEG abnormality about three times higher (65%) than those subjects charged with one violent offense (24%). See Williams, *Neural Factors Related to Habitual Aggression*, 92 BRAIN 503, 506 (1969) [hereinafter Williams, *Neural Factors*]. When all subjects with possible organic brain damage were removed from the sample, the incidence of EEG abnormalities was five times higher among the

higher incidences of EEG abnormalities among violent offenders¹²⁰ or among delinquent girls or boys.¹²¹ The relatively few offenders with serious crimes examined in some research may explain in part a lack of significant differences between groups. In turn, research results may vary with the use of activation techniques.¹²² Other research has reported more contradictory differences among offender groups on some specific EEG abnormalities.¹²³

habitual offenders than among the one-time offenders. See *id.* at 512; Williams, *Studies of Persons Confined for Crimes of Violence*, in NEURAL BASES OF VIOLENCE AND AGGRESSION, *supra* note 56, at 285, 289.

¹²⁰ See Riley, *The Electroencephalogram in Patients with Rage Attacks or Episodic Violent Behavior*, 144 MILITARY MED. 515, 516 (1979).

¹²¹ See Loomis, *EEG Abnormalities as a Correlate of Behavior in Adolescent Male Delinquents*, 121 AM. J. PSYCHIATRY 1003, 1003-06 (1965); Loomis, Bohnert & Huncke, *supra* note 113, at 496; Wiener, Delano & Klass, *supra* note 113, at 148.

¹²² See Eidelberg, *Neurophysiological Changes Induced by Psychoactive Drugs*, in NEURAL BASES OF VIOLENCE AND AGGRESSION, *supra* note 56, at 85, 86-88 (using sleep- and drug-induced activation techniques); Elliott, *Neurological Aspects of Antisocial Behavior*, in THE PSYCHOPATH: A COMPREHENSIVE STUDY OF ANTISOCIAL DISORDERS AND BEHAVIORS 146, 178-79 (W. Reid ed. 1978) [hereinafter Elliott, *Neurological Aspects*] (describing use of tolbutamide-induced hypoglycemia as activation); Green, *The Activation of Electroencephalographic Abnormalities by Tolbutamide-Induced Hypoglycemia*, 13 NEUROLOGY 192, 192-200 (1963) (using intravenous injections of tolbutamide to induce hypoglycemia as activation). See generally R. MONROE, EPISODIC BEHAVIORAL DISORDERS: A PSYCHODYNAMIC AND NEUROPHYSIOLOGIC ANALYSIS 176-224 (1970) (discussing the effects on behavior of various psychoactive drugs).

¹²³ Specific kinds of EEG abnormalities found to be associated with violence and recidivism include an EEG characterized by: an excess of slow activity; a fast spike followed by a slow wave, termed a 14-6 pattern; and temporal lobe epilepsy. One of the more consistent research findings is the presence of abnormally slow wave activity among psychopaths. See Volavka, *Electroencephalogram Among Criminals*, in THE CAUSES OF CRIME, *supra* note 2, at 137, 137-38, 142. Excessively slow wave activity has also been reported for violent offenders, assaultive or sociopathic offenders exposed to stimulation, and delinquent children. See Assael, Kohen-Raz & Alpern, *supra* note 118, at 51 (analyzing EEG abnormalities in juvenile delinquents); Blackburn, *supra* note 113, at 363 (testing the relationship between aggression and theta activity); Dobbs & Speck, *Visual Evoked Response and Frequency Density Spectra of Prisoner-Patients*, 9 COMPREHENSIVE PSYCHIATRY 62, 64-66 (1968) (studying brain wave activity among mentally ill criminals); Fenton, Tennent, Fenwick & Rattray, *The EEG in Antisocial Behaviour: A Study of Posterior Temporal Slow Activity in Special Hospital Patients*, 4 PSYCHOLOGICAL MED. 181, 181-86 (1974) [hereinafter Fenton & Tennent] (studying temporal slow wave activity in mental patients); Hill & Pond, *supra* note 114, at 29-38 (studying criminals with histories of epilepsy). In a prospective study, slow wave activity during ages 10 to 13 years predicted later multiple delinquencies. See Mednick, Volavka, Gabrielli & Itil, *EEG as a Predictor of Antisocial Behavior*, 19 CRIMINOLOGY 219, 226-27 (1981) [hereinafter Mednick, *EEG as a Predictor*]. Some studies, however, report no evidence of slow wave activity or slow and fast activity according to offender type. See *Biology and Violence*, *supra* note 1, at 47-48; Wiener, Delano & Klass, *supra* note 113, at 148. In turn, a 14-6 EEG pattern has been observed disproportionately among offender groups in some investigations but not in others. Compare Assael, Kohen-Raz & Alpern, *supra* note 118, at 51-52 (observing 14-6 pattern more often in delinquents than in normal children) and Yaryura-Tobias,

Few studies examining relationships between the EEG and criminality have used quantitative techniques,¹²⁴ although such techniques are now available.¹²⁵ Interpretation of the abnormal EEG patterns presents an additional difficulty. A recent quantitative study demonstrated a prospective association between antisocial behavior (thievery) and a slowing of alpha frequency. It suggested that the slow wave activity indicated a developmental lag, although researchers considered

Biosocial Research on Violent Behavior, in *ECOLOGIC-BIOCHEMICAL APPROACHES*, *supra* note 96, at 138, 142-43 (noting that a 14-6 pattern has been associated with violent crime) with Sayed, Lewis & Brittain, *supra* note 116, at 1123 (observing no 14-6 abnormalities) and Wiener, Delano & Klass, *supra* note 113, at 148-49 (observing no difference in 14-6 pattern frequency between delinquent and nondelinquent adolescents). Unfortunately, much of the early research on EEG and criminality did not examine or report findings with these specific patterns. The relationship between criminality and evidence of temporal lobe dysfunction or epilepsy, and their anatomical variations, has been more extensively investigated. Among violent subjects, the frequency of temporal lobe epilepsy has been found to range from about 10% to between 17% and 26% to above 75%, depending on the type of sample. See Bach-y-Rita, Lion, Climent & Ervin, *supra* note 118, at 1476-77 (diagnosing 13 of 123 subjects as having temporal lobe epilepsy); Hill & Pond, *supra* note 114, at 29-38 (finding 18 of 110 subjects to have temporal lobe epilepsy). Mark and Ervin reported that their violent offender sample had an incidence of epilepsy ten times higher than that found in the general population. See V. MARK & F. ERVIN, *supra* note 8, at 130-31. The infrequent ictal aggression occurs during a seizure, while the more common interictal behavior pattern results in uncontrolled assaultive behavior. See Shah & Roth, *supra* note 24, at 117-19; cf. Kligman & Goldberg, *Temporal Lobe Epilepsy and Aggression*, 160 *J. NERVOUS & MENTAL DISEASE* 324, 333 (1975) (questioning whether ictal and interictal events should be considered to be distinct types of events).

It is emphasized, however, that relatively few epileptics demonstrate aggressive behavior and that other emotional symptoms among epileptics predominate. See Williams, *The Structure of Emotions Reflected in Epileptic Experiences*, 79 *BRAIN* 29, 38 (1956); Yaryura-Tobias, *supra*, at 142-43. In turn, behavior pathology appears to occur only when particular neural mechanisms are affected. See Moyer, *Physiological Determinants*, *supra* note 77, at 175-84. Substantial evidence supports the conclusion that violence or aggression is not a direct outcome of an epileptic condition, but possibly an indirect outcome affected by other variables, such as learning difficulties. See Shah & Roth, *supra* note 24, at 119. In general, the relationship between temporal lobe epilepsy and criminality is not firmly established.

¹²⁴ For some exceptions, see Blackburn, *supra* note 113, at 359-61 (statistically correlating EEG with aggression); Dobbs & Speck, *supra* note 123, at 62-64 (statistically correlating EEG with criminality); Mednick, *EEG as a Predictor*, *supra* note 123, at 222-24 (using EEG results to predict delinquency); Volavka, *supra* note 123, at 139-41 (using EEG results to predict rates of recidivism among offenders).

¹²⁵ Other methods of quantifying brain electrical patterns have been developed. See Gevins, Doyle, Cutillo, Schaffer, Tannehill, Ghannam, Gilcrease & Yeager, *Electrical Potentials in Human Brain During Cognition: New Method Reveals Dynamic Patterns of Correlation*, 213 *SCIENCE* 918, 918 (1981) (discussing the use of "brain macropotentials" to study "neural processes related to purposive behaviors"); Gevins & Schaffer, *supra* note 112, at 97-98 (discussing "neurocognitive pattern analysis"); Gevins, Zeitlin, Doyle, Yingling, Schaffer, Callaway & Yeager, *Electroencephalogram Correlates of Higher Cortical Functions*, 203 *SCIENCE* 665, 665-66 (1979) (using "two-stage, nonlinear multivariate pattern recognition analysis" to derive EEG classifications related to specific activities).

other factors such as head or brain injury and genetic transmission.¹²⁶

Other techniques may reveal more about both the cause and location of cerebral injury. According to Elliott, for example, the use of the computerized axial tomography (CAT) scan is "obligatory" in neurological examinations of behavior-disordered individuals.¹²⁷ This frequently applied outpatient procedure has been particularly useful in identifying organic pathologies in individuals characterized by explosive rage.¹²⁸ In one recent study of episodically aggressive patients, the CAT scan showed structural abnormalities in forty-one percent of the cases.¹²⁹ Alternative methods for studying brain activity include measures of regional cerebral blood flow and magnetic resonance imaging.¹³⁰ In general, however, more sophisticated and systematically col-

¹²⁶ See Volavka, *supra* note 123, at 142-43. A number of different explanations have been provided concerning the origin of general or specific EEG abnormalities among offenders, particularly for an excess of slow wave activity among psychopaths and other delinquent groups. For example, some authors suggest that slow wave activity may be attributed to an underlying cortical or subcortical dysfunction, manifested in some cases by boredom or drowsiness during the EEG examination. See *Biology and Violence*, *supra* note 1, at 48 (citing Hare, *Electrodermal and Cardiovascular Correlates of Psychopathy*, in *PSYCHOPATHIC BEHAVIOR: APPROACHES TO RESEARCH* 107, 109-10, 121-22 (R. Hare & D. Schalling eds. 1978)). Other authors link slow wave activity to a maturational lag, because the activity of adult psychopaths, in particular, resembles the activity of a normal child. See Volavka, *supra* note 123, at 138. For reviews of the literature, see Assael, Kohen-Raz & Alpern, *supra* note 118, at 53-54; Hare, *supra*, at 110-12, 114. A possible link to developmental immaturity has not been supported in some recent research, however. See Fenton & Tennent, *supra* note 123, at 185; Mednick, *EEG as a Predictor*, *supra* note 123, at 227. Other possible etiological factors associated with EEG abnormalities have been shown or suggested. These include trauma before or during birth, see Fenton & Tennent, *supra* note 123, at 186, or childhood trauma, see Elliott, *Neurological Findings*, *supra* note 118, at 686-87, head injury during childhood or adulthood, see Hill & Watterson, *supra* note 119, at 59-61, CNS disorders, see *Biology and Violence*, *supra* note 1, at 54-55, attention-deficit disorder, see Yaryura-Tobias, *supra* note 123, at 144-46, and triggering metabolic or endocrine disorders such as hypoglycemia, see Hill & Pond, *supra* note 114, at 39-40; Yaryura-Tobias, *supra* note 123, at 144-46, or premenstrual tension, see Yaryura-Tobias, *supra* note 123, at 144-46. Physiological disorders at the time of the criminal event, stimulated by such factors as alcohol or drug use, have also been found. See Elliott, *Neurological Aspects*, *supra* note 122, at 158 (noting effect of alcohol on psychopaths); Shah and Roth, *supra* note 24, at 121 (noting relationship between alcohol and violent crime). Other psychological or environmental factors may be influential as well. See, e.g., Williams, *Neural Factors*, *supra* note 119, at 513 (noting "environmental stress" as a cause of murder).

¹²⁷ See Elliott, *Neurological Findings*, *supra* note 118, at 682.

¹²⁸ See Elliott, *Neurological Aspects*, *supra* note 122, at 180.

¹²⁹ See Elliott, *Neurological Findings*, *supra* note 118, at 685.

¹³⁰ An overview of these new methods may be found in Swayze, Yates & Andreasen, *Brain Imaging: Applications in Psychiatry*, 5 *BEHAVIORAL SCI. & L.* 223, 228-33 (1987). Some measures of regional cerebral blood flow (rCBF) use xenon 133 (¹³³Xe) with a multidetector device. It has been suggested that this method provides more information on distinct brain regions than do measurements of evoked potentials or electroencephalographic alterations. See Ingvar & Philipson, *Distribution of Cerebral Blood Flow in the Dominant Hemisphere During Motor Ideation and Motor*

lected neurophysiological data must be examined before definitive conclusions can be reached with regard to the prevalence and meaning of particular cerebral structures.

Once again, measurement difficulties may contribute to the dearth of cases in which defendants have attempted to use neurophysiological factors as a defense against culpability, particularly for violent crimes. Moreover, the theories linking test results to behavior may be difficult for judges and juries to accept, although there are some exceptions. For example, in *Crocodile Man*, Mayer and Wheeler provide an account of a recent Massachusetts case in which the defendant had suddenly and brutally attacked two teenage hitchhikers with a hammer.¹³¹ The defendant's insanity defense depended on the expert testimony of a specialist in the field of brain chemistry and behavior who argued that the defendant suffered from a lesion in the limbic system of the brain, portions of which are common to both humans and crocodiles. This chemical dysfunction allegedly caused the defendant's behavior to become vicious. The specific tests, an EEG and a CAT scan ordered by the judge in an attempt to demonstrate brain abnormality, proved negative. The defendant, however, was granted probation by the trial judge, who suspended an eighteen-year sentence at a correctional institution.¹³²

Other jurisdictions do not allow the introduction of such evidence at trial. In *State v. Wilcox*,¹³³ for example, a defendant diagnosed as borderline mentally retarded, schizophrenic, dyslexic, and with an organic brain syndrome could not introduce evidence of disabilities to show a lack of mental capacity for an aggravated murder and battery because Ohio does not recognize a defense of diminished capacity.¹³⁴ Thus, regardless of issues of measurement, reliability, or causality, certain evidentiary standards may preclude admissibility of medical and psychological evidence altogether.

Performance, 2 ANNALS OF NEUROLOGY 230, 230-37 (1977). A number of different indices of rCBF have been developed. See Halsey, Blauenstein, Wilson & Wills, *Regional Cerebral Blood Flow Comparison of Right and Left Hand Movement*, 29 NEUROLOGY 21, 26-27 (1979). The ¹³³Xe inhalation method, as modified, has a distinct advantage, because it is noninvasive and repeatable, despite possible drawbacks in errors of measurement. See Obrist, Thompson, Wang & Wilkinson, *Regional Cerebral Blood Flow Estimated by ¹³³Xenon Inhalation*, 6 STROKE 245, 245 (1975).

¹³¹ A. MAYER & M. WHEELER, *CROCODILE MAN* 10-14, 110-25 (1982) (chronicling the trial of an unidentified defendant on two counts of attempted murder).

¹³² See *id.* at 159-60.

¹³³ 70 Ohio St. 2d 182, 436 N.E.2d 523 (1982).

¹³⁴ See *id.* at 199, 436 N.E.2d at 533.

D. Intellectual Ability

A relatively more controversial issue in both the criminal law and social science research concerns individual differences in intellectual ability. For example, some literature shows that delinquents or criminals differ from noncriminals in intellectual functioning¹³⁵ or school achievement,¹³⁶ but there are also studies questioning whether any definite difference exists at all.¹³⁷ Early studies reporting lower intelligence scores among delinquents frequently lacked comparisons with nondelinquents or controls for socioeconomic status and involvement in the criminal justice system.¹³⁸ However, associations between low intelligence scores and delinquency remain in recent studies that use controls for many of these factors.¹³⁹

¹³⁵ See, e.g., D. LEWIS & D. BALLA, DELINQUENCY AND PSYCHOPATHOLOGY 30-33 (1976) (citing variations in psychological testing of delinquent children); M. WOLFGANG, R. FIGLIO & T. SELLIN, DELINQUENCY IN A BIRTH COHORT 60-64 (1972) [hereinafter DELINQUENCY COHORT I] (finding that race, I.Q., achievement level, and socioeconomic status are important predictors of delinquency); Bach-y-Rita, Lion, Climent & Ervin, *supra* note 118, at 1475-77 (violent patients demonstrated signs of arrested intellectual development); Gabrielli & Mednick, *Sinistrality and Delinquency*, 89 J. ABNORMAL PSYCHOLOGY 654, 658-59 (1980) (reporting a connection between learning disabilities and delinquency); Hirschi & Hindelang, *Intelligence and Delinquency: A Revisionist Review*, 42 AM. SOC. REV. 571, 571-85 (1977) (showing a strong correlation between I.Q. and delinquency); Kirkegaard-Sorenson & Mednick, *A Prospective Study of Predictors of Criminality: 5. Intelligence*, in BIOSOCIAL BASES OF CRIMINAL BEHAVIOR, *supra* note 6, at 267, 267-73 (reporting that adolescents who later commit criminal acts have a lower tested intelligence than their more law-abiding peers); Shapiro, *Delinquent and Disturbed Behaviour within the Field of Mental Deficiency*, 5 [No. 3] INT'L PSYCHIATRY CLINICS 76, 76-90 (1968) (pointing out, inter alia, difficulties of conceptualization and concrete thinking among delinquents); Spellacy, *Neuropsychological Discrimination Between Violent and Nonviolent Men*, 34 J. CLINICAL PSYCHOLOGY 49, 49-52 (1978) (violent men scored consistently lower on cognitive, perceptual, and motor skills tests than did nonviolent men).

¹³⁶ See DELINQUENCY COHORT I, *supra* note 135, at 60-61; Blanchard & Manarino, *Academic, Perceptual, and Visual Levels of Detained Juveniles*, in ECOLOGIC-BIOCHEMICAL APPROACHES, *supra* note 96, at 341, 341-51; Elliott, *Delinquency, School Attendance and Dropout*, 13 SOC. PROBS. 303, 307-14 (1966); Kirkegaard-Sorenson & Mednick, *A Prospective Study of Predictors of Criminality: 4. School Behavior*, in BIOSOCIAL BASES OF CRIMINAL BEHAVIOR, *supra* note 6, at 255, 255-66; Marshall, Hess & Lair, *The WISC-R and WRAT as Indicators of Arithmetic Achievement in Juvenile Delinquency*, 47 PERCEPTUAL & MOTOR SKILLS 408, 408-10 (1978).

¹³⁷ See D. OFFER, R. MAROHN, & E. OSTROV, THE PSYCHOLOGICAL WORLD OF THE JUVENILE DELINQUENT 145-52 (1979); Lewis, Shanok, Pincus & Glaser, *Violent Juvenile Delinquents: Psychiatric, Neurological, Psychological, and Abuse Factors*, 18 J. AM. ACAD. CHILD PSYCHIATRY 307, 307-19 (1979); Prentice & Kelly, *Intelligence and Delinquency: A Reconsideration*, 60 J. SOC. PSYCHOLOGY 327, 327-37 (1963); C. Murray, *The Link Between Learning Disabilities and Juvenile Delinquency* 65-68 (Apr. 1976) (unpublished manuscript) (available at the Sellin Center for Studies in Criminology and Criminal Law at the Wharton School, University of Pennsylvania).

¹³⁸ For a review of these studies, see G. VOLD, THEORETICAL CRIMINOLOGY 75-89 (1958).

¹³⁹ See DELINQUENCY COHORT I, *supra* note 135, at 61-63 (controlling for social

The nature and source of specific differences in intellectual functioning are not clear. Some researchers attribute lower scores in general aptitude among delinquents or criminals to a generalized intellectual disinterest.¹⁴⁰ Other researchers suggest that the low test scores may result from an intellectual imbalance shown by considerably lower verbal, as opposed to spatial, intelligence among delinquents¹⁴¹ or demonstration of significantly different levels of verbal and spatial performance.¹⁴² The substantial literature citing evidence of reading or learning disabilities¹⁴³ suggests the importance of investigating verbal and language processes in general.

Consideration of the direct and indirect correlates of learning or reading disabilities may provide further explanations for the intelligence-delinquency relationship. For example, poor reading ability has been linked to pregnancy complications,¹⁴⁴ large family size,¹⁴⁵ and lead poisoning,¹⁴⁶ as well as to cerebral dysfunction and lateralization.¹⁴⁷

class and previous contact with "authorities"); WEST & FARRINGTON, WHO BECOMES DELINQUENT? 84-98 (1973) (same); Hirschi & Hindelang, *supra* note 135, at 571-87 (1977) (same); Kirkegaard-Sorenson & Mednick, *supra* note 136, at 255-66 (same); Kirkegaard-Sorenson & Mednick, *supra* note 135, at 267-75 (same).

¹⁴⁰ See Virkkunen & Luukkonen, *WAIS (Wechsler Adult Intelligence Scale) Performances in Antisocial Personality (Disorder)*, 55 ACTA PSYCHIATRICA SCANDINAVICA 220, 223 (1977) (explaining that low test scores could be the result of "a lack of general interest and intellectual curiosity").

¹⁴¹ See W. McCORD & J. McCORD, THE PSYCHOPATH: AN ESSAY ON THE CRIMINAL MIND 82-87 (1964); Andrew, *Violence and Poor Reading*, 17 CRIMINOLOGY 361, 361-65 (1979).

¹⁴² See, e.g., D. LEWIS & D. BALLA, *supra* note 135, at 30-33 (reporting for some delinquents perceptual-motor skills far below verbal skills as well as marked variability in performance within individual tests); Mayers, Townes & Reitan, *Adaptive Abilities among Delinquent and Non-delinquent Boys* app. B at 3 (1974) (available at the Sellin Center for Studies in Criminology and Criminal Law at the Wharton School, University of Pennsylvania) (showing considerably greater intellectual ability in areas involving visuo-spatial types of problems than in the area of verbal and symbolic functions for delinquents).

¹⁴³ See Andrew, *supra* note 141, at 361-65; Kinsbourne & Warrington, *Developmental Factors in Reading and Writing Backwardness*, in THE DISABLED READER 59, 59-71 (J. Money ed. 1966); R. Fogel, GAO Presentation Before the International Conference of the Association for Children with Learning Disabilities on Review of the Relationship of Learning Problems to Juvenile Delinquency 1-5 (Mar. 4, 1976) (text available at the Sellin Center for Studies in Criminology and Criminal Law at the Wharton School, University of Pennsylvania).

¹⁴⁴ See Kawi & Pasamanick, *Association of Factors of Pregnancy with Reading Disorders in Childhood*, 166 J. A.M.A. 1420, 1420-23 (1958).

¹⁴⁵ See Zajonc & Markus, *Birth Order and Intellectual Development*, 82 PSYCHOLOGICAL REV. 74, 74-88 (1975).

¹⁴⁶ See de la Burde & Choate, *Early Asymptomatic Lead Exposure and Development at School Age*, 87 J. PEDIATRICS 638, 638-42 (1975); Smith, *Recent Work on Low Level Lead Exposure and Its Impact on Behavior, Intelligence, and Learning: A Review*, 24 J. AM. ACAD. CHILD PSYCHIATRY 24, 31 (1985); Boffey, *After Years of Cleanup, Lead Poisoning Persists as a Threat to Health*, N.Y. Times, Sept. 1, 1988,

There is also some indication that delinquents have a higher proportion of visual defects than nondelinquents, which can contribute to learning disabilities.¹⁴⁸ In turn, there is evidence that delinquents or criminals have a disproportionate incidence of left side preference.¹⁴⁹ Again, more extensive research using multiple measures of learning disabilities must be conducted to support more definitive conclusions.

Courts appear mixed in their consideration of mental and emotional deficits when determining competency to stand trial or culpability in general.¹⁵⁰ Although part of this inconsistency may result from the varied factual circumstances presented, no case has established a firm standard for deciding when a particular mental state, short of insanity, constitutes a defense against allegedly criminal behavior. Such

at B14, col.1.

¹⁴⁷ See Carter-Saltzman, *Patterns of Cognitive Functioning in Relation to Handedness and Sex-Related Differences*, in *SEX-RELATED DIFFERENCES IN COGNITIVE FUNCTIONING: DEVELOPMENTAL ISSUES* 97, 97-118 (M. Wittig & A. Petersen eds. 1979).

¹⁴⁸ See Allen, *The Role of Vision in Learning Disorders*, 10 *J. LEARNING DISABILITIES* 411, 411-15 (1977); Barnes & O'Gorman, *Some Medical and Social Features of Delinquent Boys*, 71 *J. IRISH MED. A.* 19, 19-22 (1978).

¹⁴⁹ Studies examining a possible association between left side preference and delinquency, however, report conflicting results. For example, some research has found a disproportionate number of left-handers among delinquent or criminal populations. See Andrew, *Laterality on the Tapping Test Among Legal Offenders*, 7 *J. CLINICAL CHILD PSYCHOLOGY* 149, 149-50 (1978); Fitzhugh, *Some Neuropsychological Features of Delinquent Subjects*, 36 *PERCEPTUAL & MOTOR SKILLS* 494, 494 (1973); Gabrielli & Mednick, *supra* note 135, at 654-61; Krynicki, *Cerebral Dysfunction in Repetitively Assaultive Adolescents*, 166 *J. NERVOUS & MENTAL DISEASE* 59, 59-67 (1978); Palmer, *Hand Differentiation and Psychological Functioning*, 31 *J. PERSONALITY* 445, 445-61 (1963). Other research has not found a disproportionate number of left-handers among delinquents. See, e.g., Hare, *Psychopathy and Laterality of Cerebral Function*, 88 *J. ABNORMAL PSYCHOLOGY* 605, 605-10 (1979) (reporting that psychopathy is not associated with readily discernible dysfunction of the left hemisphere).

¹⁵⁰ *Compare* *People v. Montanez*, 90 A.D.2d 476, 476-77, 455 N.Y.S.2d 268, 269 (1982) (holding that the mental, emotional, and psychological history of a 16-year-old girl justified reducing her conviction of robbery in the first degree to a conviction in the third degree) and *People v. Stankewitz*, 32 Cal. 3d 80, 93, 648 P.2d 578, 585, 184 Cal. Rptr. 611, 618 (1982) (holding that a 19-year-old with the mental and emotional level of an impulsive 14- or 15-year-old should have been given a hearing on the issue of competence to stand trial) *with* *People v. Holman*, 115 Ill. App. 3d 60, 65-66, 450 N.E.2d 432, 435 (1983) (holding that a borderline mentally retarded defendant, who had neurological damage and an abusive home background, was competent to stand trial for the murder of his grandmother) and *May v. State*, 398 So. 2d 1331, 1336 (Miss. 1981), *aff'd*, 435 So. 2d 1181 (Miss. 1983) (holding that the feeble-mindedness of a retarded 14-year-old boy was no defense to an armed robbery prosecution unless he did not appreciate the nature and quality of the act or could not distinguish between right and wrong at the time the offense was committed) and *People v. Belcher*, 269 Cal. App. 2d 215, 220, 74 Cal. Rptr. 602, 605 (1969) (concluding that a defendant suffering brain damage from lead poisoning was not insane at the time he committed a burglary, because "abnormal" behavior is not the same as insanity in the eyes of the law).

ambiguity also applies to other kinds of mental and motor difficulties, such as attention-deficit disorder and minimal brain dysfunction, that are prevalent among criminal populations, but are rarely mentioned as mitigating factors in assessing behavioral responsibility.

E. *Attention Deficit Disorder and Minimal Brain Dysfunction*

Attention deficit disorder (ADD) is a term used to classify a broad range of emotional and behavioral disabilities including minimal brain dysfunction (MBD) and hyperactivity. Because the terminology in this area of study has fluctuated over the years, and because the types of behaviors are often interrelated, the following discussion will use the term "ADD-MBD complex" to characterize those behaviors characteristic of either ADD or MBD.¹⁵¹ The term "hyperactivity" will be retained, because it is often used to distinguish a particular set of disorders.¹⁵²

ADD-MBD complex and hyperactivity are noted correlates of school failure and delinquency.¹⁵³ The term hyperactivity in particular describes the heterogenous behaviors of children who show one or more of the following: overactivity, perceptual-motor impairment, impulsiveness, emotional lability, short attention span, and antisocial responses.¹⁵⁴ Children with below-normal intelligence or very severe neu-

¹⁵¹ The term "ADD-MBD complex" and the rationale for it were suggested to me in a personal communication with Frank A. Elliott, M.D., Emeritus Professor of Neurology, University of Pennsylvania. The most recent description of ADD can be found in AMERICAN PSYCHIATRIC ASS'N, DIAGNOSTIC AND STATISTICAL MANUAL OF MENTAL DISORDERS (1987) [hereinafter DIAGNOSTIC AND STATISTICAL MANUAL].

¹⁵² The literature on MBD and hyperactivity is extensive. A thorough discussion of the MBD/hyperkinetic syndrome and the various terms used to describe it can be found in H. Rie, *Definitional Problems*, in HANDBOOK OF MINIMAL BRAIN DYSFUNCTIONS 3, 3-17 (H. Rie & E. Rie eds. 1980).

¹⁵³ See Curman & Nylander, *A 10-Year Prospective Follow-up Study of 2268 Cases at the Child Guidance Clinics in Stockholm*, 260 ACTA PAEDIATRICA SCANDINAVICA SUPPLEMENTUM 1, 1-71 (1976); Denhoff, *The Natural Life History of Children with Minimal Brain Dysfunction*, 205 ANNALS N.Y. ACAD. SCI. 188, 188-205 (1973); Elliott, *Neurological Factors*, *supra* note 96, at 367-69; Elliott, *Neurological Findings*, *supra* note 118, at 307-14; Menkes, Rowe & Menkes, *A Twenty-Five Year Follow-up Study on the Hyperkinetic Child with Minimal Brain Dysfunction*, 39 PEDIATRICS 393, 393-99 (1967); Satterfield, *Childhood Diagnostic and Neurophysiological Predictors of Teenage Arrest Rates: An Eight Year Prospective Study*, in THE CAUSES OF CRIME, *supra* note 2, at 146, 160-66.

¹⁵⁴ See P. WENDER, MINIMAL BRAIN DYSFUNCTION IN CHILDREN 9-24 (1971); Firestone, Peters, Rivier & Knights, *Minor Physical Anomalies in Hyperactive, Retarded and Normal Children and Their Families*, 19 J. CHILD PSYCHOLOGY & PSYCHIATRY & ALLIED DISCIPLINES 155, 155 (1978) [hereinafter Firestone & Peters]; Loney, Langhorne & Paternite, *An Empirical Basis for Subgrouping the Hyperkinetic/Minimal Brain Dysfunction Syndrome*, 87 J. ABNORMAL PSYCHOLOGY 431, 431 (1978).

rological problems are excluded by definition from classification as either hyperactive or having the ADD-MBD complex.¹⁵⁵ The origins of the ADD-MBD complex include prenatal or birth trauma,¹⁵⁶ neurodevelopmental lag,¹⁵⁷ minor physical anomalies,¹⁵⁸ genetic transmission,¹⁵⁹ and disorganized or chaotic living environments.¹⁶⁰

Problem behaviors among affected children appear to correspond to age. For example, young children between two and six years old may exhibit a lack of discipline and hyperactivity, while older children in elementary school or adolescence may demonstrate reading and learning disorders, academic underachievement, and delinquent or aggressive behavior.¹⁶¹ Central nervous system dysfunction may underlie some childhood disorders,¹⁶² but evidence suggests that deviations can result from developmental or maturational lags that many children eventually "outgrow."¹⁶³ Longitudinal follow-up studies indicate that children who do not outgrow behavioral disorders may retain antisocial conduct into adulthood.¹⁶⁴

Few criminal defendants have argued that problems associated with the ADD-MBD complex should excuse their behavior, although courts have not indicated an unwillingness to consider such information. In *Hendershott v. People*,¹⁶⁵ for example, the defense offered psychiatric and psychological information to show that the defendant suffered from adult minimal brain dysfunction. The Colorado Supreme Court concluded that such evidence of mental impairment, which could possibly mitigate the defendant's culpability, had been improperly

¹⁵⁵ This widely adopted, partial definition of MBD—discussed by Clements and referred to by Rie and Rie—was formulated by the first of three task forces on the subject, which focused on terminology and identification. See H. Rie, *supra* note 152, at 4 ("The term "minimal brain dysfunction syndrome" refers . . . to children of near average, average or above average general intelligence with certain learning or behavioral disabilities ranging from mild to severe, which are associated with deviations of function of the central nervous system.") (quoting S. CLEMENTS, MINIMAL BRAIN DYSFUNCTION IN CHILDREN—TERMINOLOGY AND IDENTIFICATION 9 (1966)).

¹⁵⁶ See P. NICHOLS & T. CHEN, MINIMAL BRAIN DYSFUNCTION: A PROSPECTIVE STUDY 106-20 (1981); Towbin, *Organic Causes of Minimal Brain Dysfunction: Perinatal Origin of Minimal Cerebral Lesions*, 217 J. A.M.A. 1207, 1207-14 (1971).

¹⁵⁷ See Firestone & Peters, *supra* note 154, at 155.

¹⁵⁸ See *id.* at 155-56.

¹⁵⁹ See Morrison & Stewart, *Evidence for Polygenetic Inheritance in the Hyperactive Child Syndrome*, 130 AM. J. PSYCHIATRY 791, 791-92 (1973).

¹⁶⁰ See DIAGNOSTIC AND STATISTICAL MANUAL, *supra* note 151, at 51.

¹⁶¹ See *id.* at 52 (listing diagnostic criteria); P. WENDER, *supra* note 154, at 24-26 (describing the behavioral patterns associated with the ADD-MBD complex).

¹⁶² See D. LEWIS & D. BALLA, *supra* note 135, at 65.

¹⁶³ See Elliott, *Neurological Factors*, *supra* note 96, at 374.

¹⁶⁴ See *id.* at 367-69; Shah & Roth, *supra* note 24, at 129.

¹⁶⁵ 653 P.2d 385 (Colo. 1982), *cert. denied*, 459 U.S. 1225 (1983).

excluded.¹⁶⁶

Although studies show that some disorders, such as the ADD-MDB complex, are related to other disabilities, such as intellectual impairment, research has not yet clarified how select psychological and biological characteristics interact or relate to behavioral responsibility in general. The following Sections discuss theories suggesting possible links between intellectual impairment and crime and how such relationships may be viewed in the context of a broader philosophy of behavior.

F. *Aggravating and Intervening Factors*

This presentation of research on biological and environmental explanations of crime is not exhaustive; numerous other factors and theories have also been examined. Some of these factors can be considered as aggravating, or as intervening between, a biological disorder and law-breaking behavior. Others may have a direct association with crime that depends upon an individual's propensity toward criminal behavior. For example, researchers have found significant links between crime or behavioral disorders and gender,¹⁶⁷ alcohol,¹⁶⁸ head injury,¹⁶⁹ physical growth and development,¹⁷⁰ and a history of child abuse and neglect.¹⁷¹

¹⁶⁶ See *id.* at 394.

¹⁶⁷ At birth, a child's sex is one of the most accurate determinants of later criminal behavior. See Andrew, *Delinquency: Correlating Variables*, 10 J. CLINICAL CHILD PSYCHOLOGY 136, 138 (1981); Elliott, *Neurological Factors*, *supra* note 96, at 362-63; Moyer, *Sex Differences in Aggression*, in SEX DIFFERENCES IN BEHAVIOR 335 (R. Friedman, R. Richart & R. Vande Wiele eds. 1974).

¹⁶⁸ See *supra* note 100 and accompanying text.

¹⁶⁹ See V. MARK & F. ERVIN, *supra* note 8, at 56-57, 70-71; G. SIANN, *supra* note 72, at 29; Elliott, *Neurological Factors*, *supra* note 96, at 372; *Biology and Violence*, *supra* note 1, at 54-55.

¹⁷⁰ Physical growth, even at an early age, is one of several indicators of subsequent health and development and physical maturation during adolescence. See A MIXED-LONGITUDINAL INTERDISCIPLINARY STUDY OF GROWTH AND DEVELOPMENT (B. Prah-Andersen, C. Kowalski & P. Heydendael eds. 1979) (collection of articles discussing the Nymegen Growth Study). According to Great Britain's National Child Development Study, low height at age seven within a sample of nearly 15,000 children was associated with low socioeconomic status, large family size, young maternal age, and late birth order, controlling for other important variables. See R. DAVIE, N. BUTLER & H. GOLDSTEIN, FROM BIRTH TO SEVEN 81-86 (1972).

¹⁷¹ See M. STRAUS, R. GELLES & S. STEINMETZ, BEHIND CLOSED DOORS: VIOLENCE IN THE AMERICAN FAMILY 107-08 (1980); Garabedian, *Synthesis of Literature on Linkage Between Child Abuse, Neglect, and Delinquency*, in A PRELIMINARY NATIONAL ASSESSMENT OF CHILD ABUSE AND NEGLECT AND THE JUVENILE JUSTICE SYSTEM: THE SHADOWS OF DISTRESS 123, 138-39 (C. Smith, D. Berkman & W. Fraser eds. 1980); Gelles, *Domestic Criminal Violence*, in CRIMINAL VIOLENCE 201, 219-220 (M. Wolfgang & N. Weiner eds. 1982); Lewis & Shanok, *Medical Histories of Delinquent and Nondelinquent Children: An Epidemiological Study*, 134 AM. J. PSYCHIATRY 1020, 1021-23 (1977); Steinmetz, *The Use of Force for Resolving Family*

Critical to understanding associations among these factors and crime, however, are socioeconomic, familial, and sociological influences. For example, unmarried and young mothers from lower socioeconomic groups have a relatively higher incidence of birth complications and low-birth-weight infants.¹⁷² Both factors put their infants at a higher risk of infant mortality, mental retardation, attention deficit disorder, and other physical and neurological disorders.¹⁷³ In light of this chain of relationships, biological and psychological studies of delinquency and crime should include sociological and environmental effects on crime. Unfortunately, they rarely do. The next Section provides a review of selected social and environmental factors to examine their importance.

G. Socioeconomic, Familial, and Sociological Influences

Depending on the type of measure used, criminological research generally demonstrates a disproportionate involvement of the lower socioeconomic classes in crime.¹⁷⁴ However, not all lower-class youths be-

Conflict: The Training Ground for Abuse, 26 FAM. COORDINATOR 19, 25 (1977).

¹⁷² See K. NISWANDER & M. GORDON, THE WOMEN AND THEIR PREGNANCIES 51-71 (1972); I PUBLIC HEALTH SERVICE, U.S. DEP'T OF HEALTH AND HUMAN SERVICES, VITAL STATISTICS OF THE U.S. 1985: NATALITY 250-51 tables 1-85 & 1-86 (1985).

¹⁷³ See S. BROMAN, P. NICHOLS & W. KENNEDY, PRESCHOOL IQ: PRENATAL AND EARLY DEVELOPMENTAL CORRELATES 239-55 (1975); J. HARDY, J. DRAGE & E. JACKSON, THE FIRST YEAR OF LIFE 64-69, 261-89 (1979); K. NISWANDER & M. GORDON, *supra* note 172, at 29-35; ONTARIO DEP'T OF HEALTH, SECOND REPORT OF THE PERINATAL MORTALITY STUDY IN TEN UNIVERSITY TEACHING HOSPITALS 28-29 (1967); Harlap, Davies, Grover & Prywes, *The Jerusalem Perinatal Study: The First Decade, 1964-73*, 13 ISR. J. MED. SCI. 1073, 1083, 1089 (1977).

¹⁷⁴ For a review and analysis of literature examining the relationship between violent behavior and social class, see Brownfield, *Social Class and Violent Behavior*, 24 CRIMINOLOGY 421 (1986). Some researchers, however, dispute the strength of the socioeconomic status-crime interrelationship. See, e.g., Tittle, Villemez & Smith, *The Myth of Social Class and Criminality: An Empirical Assessment of the Empirical Evidence*, 43 AM. SOC. REV. 643, 650-53 (1978) [hereinafter *Myth of Social Class*] (discussing interpretations of the "historical decline in association between social class and crime/delinquency"). Generally, findings vary according to the types of data analyzed, study times and locations, measures of social class and delinquency, research methodology, and different sample sizes and composition. See Luchterhand & Weller, *Effects of Class, Race, Sex, and Educational Status on Patterns of Aggression of Lower-Class Youth*, 5 J. YOUTH & ADOLESCENCE 59, 60 (1976); Tittle & Villemez, *Social Class and Criminality*, 56 SOC. FORCES 474, 474-76 (1977); *Myth of Social Class*, *supra*, at 651-53; Van Dusen, Mednick, Gabrielli & Hutchings, *Social Class and Crime in an Adoption Cohort*, 74 J. CRIM. L. & CRIMINOLOGY 249, 249-269 (1983). Particularly notable are the comparisons between self-reported and official measures of delinquency that, in some studies, reflect discrepant results concerning demographic and socioeconomic influences. See, e.g., R. HOOD & R. SPARKS, KEY ISSUES IN CRIMINOLOGY 46-79 (1970) (self-reported data provide a more accurate representation of delinquent behavior than official records); Elliott & Ageton, *Reconciling Race and Class Differences in Self-Reported and Official Estimates of Delinquency*, 45 AM. SOC. REV. 95, 107

come delinquent;¹⁷⁵ other social and environmental pressures exist.¹⁷⁶ Regardless of conflicting perspectives on the importance of socioeconomic disadvantage to these pressures,¹⁷⁷ studies concur in the conclusion that the normative structures in a community strongly influence the criminal behavior of youths.¹⁷⁸

Within the last decade, researchers have investigated additional community factors relating to delinquency and crime. These factors in-

(1980) ("Self-report studies are capturing a broader range of persons and levels of involvement in delinquent behavior than are official arrest statistics."); Gold & Reimer, *Changing Patterns of Delinquent Behavior among Americans 13 through 16 Years Old: 1967-72*, 7 CRIME & DELINQUENCY LITERATURE 483, 483, 514 (1975) (stating that self-reported data are more likely to reflect real levels of delinquent behavior than official data); Williams & Gold, *From Delinquent Behavior to Official Delinquency*, 20 SOC. PROBS. 209, 226 (1972) (stating that "official measures of delinquency do not accurately reflect delinquent behavior" self-reported by juveniles). *But see, e.g.*, Hindelang, Hirschi & Weis, *Correlates of Delinquency: The Illusion of Discrepancy Between Self-Report and Official Measures*, 44 AM. SOC. REV. 995, 1009-12 (1979) [hereinafter *Correlates of Delinquency*] (stating that the discrepancy between self-reported and official data is "illusory" because they actually measure discrete aspects of delinquent behavior).

¹⁷⁵ See Kvaraceus & Miller, *Norm-Violating Behavior and Lower-Class Culture*, in READINGS IN JUVENILE DELINQUENCY 88, 96-98 (R. Cavan 3d ed. 1975).

¹⁷⁶ For example, Clark and Wenninger reported that socioeconomic status becomes a significant variable in the total incidence of criminality only when an urban area reaches a certain size or composition, although lower-class youths self-report a disproportionate involvement in serious offenses regardless of density and composition. See Clark & Wenninger, *Socioeconomic Class and Area as Correlates of Illegal Behavior among Juveniles*, in JUVENILE DELINQUENCY: A BOOK OF READINGS 213, 224 (R. Giallombardo 2d ed. 1972). Danziger's economic model of crime rates in 222 urban areas also shows a general increase in crime with increasing urban growth. However, unemployment, low income, low education, and race maintain significant associations with crime, again, regardless of fluctuations in population density. See Danziger, *Explaining Urban Crime Rates*, 14 CRIMINOLOGY 291, 291-95 (1976).

¹⁷⁷ Evidence that crime is associated with community and urban factors was first compiled on a large scale by Shaw and McKay in Chicago and other metropolitan areas. See C. SHAW & H. MCKAY, *JUVENILE DELINQUENCY AND URBAN AREAS* (rev. ed. 1969). Some subsequent related research has confirmed their conclusion that high rates of delinquency are concentrated in socioeconomically deprived areas. See Chilton, *Continuity in Delinquency Area Research: A Comparison of Studies for Baltimore, Detroit, and Indianapolis*, 29 AM. SOC. REV. 71, 82-83 (1964); Gordon, *Issues in the Ecological Study of Delinquency*, 32 AM. SOC. REV. 927, 943-44 (1967). However, others contend that social instability, residential proximity, and racial discrimination, not merely socioeconomic deprivation, account for the association between community characteristics and delinquency. See B. LANDER, *TOWARDS AN UNDERSTANDING OF JUVENILE DELINQUENCY* 78-83, 88-90 (1954); Block, *Community, Environment, and Violent Crime*, 17 CRIMINOLOGY 46, 55-56 (1979); Bordua, *Juvenile Delinquency and "Anomie": An Attempt at Replication*, 6 SOC. PROBS. 230, 236-37 (1958).

¹⁷⁸ See, e.g., Rand, *Transitional Life Events and Desistance from Delinquency and Crime*, in FROM BOY TO MAN, FROM DELINQUENCY TO CRIME 134, 161-62 (M. Wolfgang, T. Thornberry & R. Figlio eds. 1987) (finding a negative correlation between family life, education, and military service and delinquency and crime, but a positive correlation with gang membership).

clude weak attachment to the neighborhood,¹⁷⁹ as shown, for example, by frequent moves,¹⁸⁰ number of multifamily dwellings, population density, and dangerous physical environment.¹⁸¹ Other theories of crime emphasize the social/psychological characteristics of delinquency in terms of the "controls" or social bonds that create and perpetuate acceptable standards of behavior.¹⁸²

Some research has linked to delinquency and its correlates various familial and parental variables, such as broken homes¹⁸³ and the absence of the father.¹⁸⁴ These variables have different effects according to the sex and race of the delinquent.¹⁸⁵ The McCords' longitudinal study of the effects of parental role models on crime demonstrates that children are most apt to imitate their criminal fathers when home conditions are unstable.¹⁸⁶ Other studies, however, report either no relationship between broken homes and delinquency,¹⁸⁷ or a considerably more negative relationship for delinquent girls than delinquent boys.¹⁸⁸ Additional family-related variables may confound these associations.¹⁸⁹ Like the previously reviewed research, studies on socioeconomic and socio-

¹⁷⁹ See J. WILSON & R. HERRNSTEIN, *supra* note 1, at 289-311.

¹⁸⁰ See DELINQUENCY COHORT I, *supra* note 135, at 253.

¹⁸¹ See J. WILSON & R. HERRNSTEIN, *supra* note 1, at 289-311.

¹⁸² See T. HIRSCHI, CAUSES OF DELINQUENCY 3-4, 10-11, 16-34, 230-31 (1969); E. SUTHERLAND & D. CRESSEY, PRINCIPLES OF CRIMINOLOGY 82-96 (6th ed. 1960).

¹⁸³ For a review of the relevant literature, see J. WILSON & R. HERRNSTEIN, *supra* note 1, at 245-53; Monahan, *Family Status and the Delinquent Child: A Reappraisal and Some New Findings*, 35 SOC. FORCES 250, 250-54 (1957); Rosen, *The Broken Home and Male Delinquency*, in THE SOCIOLOGY OF CRIME AND DELINQUENCY 489 (M. Wolfgang, L. Savitz, & N. Johnston eds. 1970).

¹⁸⁴ See Virkkunen, *Parental Deprivation and Recidivism in Juvenile Delinquents*, 16 BRIT. J. CRIMINOLOGY 378, 378-79 (1976).

¹⁸⁵ See Austin, *Race, Father-Absence, and Female Delinquency*, 15 CRIMINOLOGY 487, 501-02 (1978); Datesman & Scarpitti, *Female Delinquency and Broken Homes: A Reassessment*, in WOMEN, CRIME, AND JUSTICE 129, 144-46 (S. Datesman & F. Scarpitti eds. 1980).

¹⁸⁶ See McCord & McCord, *The Effects of Parental Role Model on Criminality*, in READINGS IN JUVENILE DELINQUENCY 302, 306 (R. Cavan 3d ed. 1975).

¹⁸⁷ See Andrew, *Delinquency: Correlating Variables*, 10 J. CLINICAL CHILD PSYCHOLOGY 136, 136 (1981).

¹⁸⁸ See C. BARTOL, CRIMINAL BEHAVIOR: A PSYCHOSOCIAL APPROACH 120 (1980).

¹⁸⁹ For example, large families, with four or more children, appear to have a higher incidence of delinquency among males than smaller families. See Andrew, *Delinquency, Sex, and Family Variables*, 23 SOC. BIOLOGY 168, 168-70 (1976). In one study, large intact families "produced the most violent male offenders." See Andrew, *Violence Among Delinquents by Family Intactness and Size*, 25 SOC. BIOLOGY 243, 249 (1978). Barnes and O'Gorman and others reported that delinquency occurs in large families in which boys far outnumber girls, presumably creating an aggressive environment. See Barnes & O'Gorman, *supra* note 148, at 21-22; see also Andrew, *supra* note 187, at 136 (reporting a higher incidence of delinquency among father-absent children when the older siblings are male).

logical factors have reached conflicting conclusions and depend in part on external effects.

The previous review and critique of recent research on biological and environmental explanations of crime can be summarized very generally. First, the evidence for much of the research is suggestive only; none of the studies can be presumed to be conclusive despite the assumptions of cause and effect implied by some of the authors. Second, many of the studies have serious methodological weaknesses, which have an unknown degree of impact on the results. In each of the topic areas, the research needs considerable replication to ensure valid and reliable outcomes. Third, most of the studies examine a few variables without considering the potential simultaneous effects and interrelationships that may exist among the numerous other biological and environmental factors. Thus, most biological and environmental studies of crime remain isolated in their particular disciplines.

II. ANALYSIS OF BIOLOGICAL AND ENVIRONMENTAL PREDICTORS OF CRIME

A. *The Concept of Cause in the Social Sciences*

Based on the analysis in Part I of this Comment, it can be argued that the presence of certain individual characteristics or life circumstances can enhance the probability that some members of a group may engage in a criminal act; however, it cannot yet be concluded that either biological or environmental factors truly "cause" crime in general or a specific incident. Such conclusions regarding cause and effect, however, are standard in the social, as well as many physical, sciences and, more theoretically, in the philosophy of science. In general, the notion of "cause" differs between the social sciences¹⁹⁰ and the criminal law¹⁹¹ and, perhaps for this reason, the two fields frequently clash.¹⁹² Social

¹⁹⁰ See, e.g., Brodbeck, *Explanation, Prediction, and "Imperfect" Knowledge*, in READINGS IN THE PHILOSOPHY OF THE SOCIAL SCIENCES 363, 379-80, 390-93 (M. Brodbeck ed. 1968) (explaining that any general-sounding causal laws in the social sciences, like "A causes X," necessarily assume the qualification "under the necessary specific circumstances"); cf. THE BASIC WRITINGS OF BERTRAND RUSSELL: 1903-1959, at 311-319 (R. Egner & L. Denonn eds. 1961) [hereinafter BERTRAND RUSSELL] (arguing that "[t]he traditional concept of cause and effect is one which modern science shows to be fundamentally erroneous" and one that must be replaced with "laws of change" that see natural occurrences not as events but as part of a process).

¹⁹¹ See Moore, *Causation and the Excuses*, 73 CALIF. L. REV. 1091, 1092-93 (1985) (describing causal theories in criminal law as simple cause and effect under any circumstances).

¹⁹² See J. MARSHALL, LAW AND PSYCHOLOGY IN CONFLICT 43 (2d ed. 1980) (discussing how the rules of evidence, which limit witness testimony to direct observa-

scientists speak not so much in terms of "cause-and-effect," but instead in terms of "laws of change,"¹⁹³ paradigms,¹⁹⁴ models and theories,¹⁹⁵ hypothesis testing,¹⁹⁶ and "falsification."¹⁹⁷

Such terminology perhaps reflects both a general philosophy and a methodological necessity: apart from certain fields, the social sciences have demonstrated a poor record of prediction in their use of statistical models. Moreover, courts have been generally unwilling to consider statistical data in their decisionmaking. The Supreme Court recently showed this reluctance in *McCleskey v. Kemp*,¹⁹⁸ in which the Court found difficulties in accepting statistical evidence of racial discrimination in death penalty sentencing.¹⁹⁹ The lower courts in *McCleskey* challenged even the validity of social science research.²⁰⁰

In light of this background, the following Sections describe an in-depth study (the "Biosocial Study" or "study") of biological and environmental explanations of crime across the lifespans of a group of nearly 1,000 young adults. The Biosocial Study, in an effort to decipher effects and interrelationships over time, examined simultaneously a variety of variables found to be important predictors of crime.²⁰¹ Although a "causal" multivariate model was applied to the data, the study's results were described in terms of interrelationships and associa-

tions and exclude inferential conclusions, necessarily conflict with what is known about the human psychology's penchant for unconsciously drawing inferences when perceiving any event).

¹⁹³ See BERTRAND RUSSELL, *supra* note 190, at 311.

¹⁹⁴ See A. KAPLAN, *THE CONDUCT OF INQUIRY: METHODOLOGY FOR BEHAVIORAL SCIENCE* 116-19 (1964); see also Masterman, *The Nature of a Paradigm*, in *CRITICISM AND THE GROWTH OF KNOWLEDGE* 59, 61-66 (I. Lakatos & A. Musgrave eds. 1970) (discussing and categorizing philosopher T.S. Kuhn's different definitions of paradigm).

¹⁹⁵ See A. KAPLAN, *supra* note 194, at 263-65; Brodbeck, *Models, Meaning, and Theories*, in *READINGS IN THE PHILOSOPHY OF THE SOCIAL SCIENCES* 579, 582-85 (M. Brodbeck ed. 1968).

¹⁹⁶ See A. KAPLAN, *supra* note 194, at 88-89.

¹⁹⁷ Lakatos, *Falsification and the Methodology of Scientific Research Programmes*, in *CRITICISM AND THE GROWTH OF KNOWLEDGE*, *supra* note 194, at 91, 95-103.

¹⁹⁸ 107 S. Ct. 1756 (1987).

¹⁹⁹ See *id.* at 1777-78.

²⁰⁰ The rejected research was a highly sophisticated study conducted by David Baldus and his colleagues. See D. Baldus, G. Woodworth & C. Pulaski, *Equal Justice and the Death Penalty: A Legal and Empirical Analysis* (1987) (unpublished manuscript) [hereinafter Baldus]. The authors addressed, and in many cases denounced, in detail the methodological criticisms of their study raised in *McCleskey v. Zant*, 580 F. Supp. 338, 354-64 (N.D. Ga. 1984), and *McCleskey v. Kemp*, 753 F.2d 877, 895-98 (11th Cir. 1985). See Baldus, *supra*, chs. 12-13.

²⁰¹ A detailed description of the theory and methodology of this study may be found in D. DENNO, *BIOLOGY AND VIOLENCE: FROM BIRTH TO ADULTHOOD* (forthcoming 1989).

tions, in keeping with traditional methods of interpretation in the social sciences. The model attempted to assess more precisely the interplay between biology, environment, and crime in an effort to ascertain the feasibility of using these relationships in criminal law defenses and as mitigating factors in sentencing.

B. *The Study and the Study Sample*

All of the 987 subjects who were the focus of the study were born at Pennsylvania Hospital, in Philadelphia, between 1959 and 1962. The subjects and their families were originally part of the Collaborative Perinatal Project, one of the largest medical projects ever conducted in this country.²⁰² Researchers selected the subjects from the first four cohorts of 2,958 black mothers who participated in the Philadelphia Perinatal Project.²⁰³ A sample of white subjects was too limited in size to be included in the analyses of delinquency.²⁰⁴

²⁰² In 1957, the National Institute of Neurological Diseases and Stroke launched the Collaborative Perinatal Project, a nationwide study of biological and environmental influences on pregnancy and infant and childhood mortality as well as physical, neurological, and psychological development in children. Nearly 60,000 pregnant women participated in the study between 1959 and 1966 in 15 different medical centers. Examination of the study children from the time of their birth through age seven continued until 1974. For further descriptions of the Perinatal Project, see S. CHIPMAN, A. LILIENFELD, B. GREENBERG & J. DONNELLY, *RESEARCH METHODOLOGY AND NEEDS IN PERINATAL STUDIES* 139-75 (1966); K. NISWANDER & M. GORDON, *supra* note 172, at 3-7. In 1978, the Sellin Center for Studies in Criminology and Criminal Law at the University of Pennsylvania was awarded a grant by the National Institute of Justice to examine those Perinatal Project children who were born in Philadelphia. As part of the grant, public school and police record data were collected on a total sample of about 10,000 youths. For eight years, detailed data have been organized and analyzed on a subsample consisting of the nearly 1,000 youths who constitute the subjects for this study.

²⁰³ The Philadelphia sample was the second largest in the Perinatal Project. It comprised the nearly 10,000 pregnant patients who delivered their children at Pennsylvania Hospital between 1959 and 1965; the children were later tested at Children's Hospital of the University of Pennsylvania. All pregnant women who attended Pennsylvania Hospital during this time were included in the study except for unregistered emergency deliveries and those women who were planning to deliver elsewhere. The total sample reflects, in part, the characteristics of families who would be interested in receiving inexpensive maternity care provided by a public clinic. The sample was 87 percent black, and its socioeconomic level was slightly lower, see K. NISWANDER & M. GORDON, *supra* note 172, at 10, 495, 498, by one decile, see Myriantopoulos & French, *An Application of the U.S. Bureau of the Census Socioeconomic Index to a Large, Diversified Patient Population*, 2 *SOC. SCI. & MED.* 283, 288 & fig. 1 (1968), than that of the U.S. population at the time.

²⁰⁴ The racial and socioeconomic bias of this sample limits the extent to which the results of this study can be generalized. However, this same bias of homogeneity provides built-in controls for the demographic and ethnic factors that have been strongly linked to delinquency and its correlates. Indeed, this study focuses upon those individuals who, in light of past research, are at a high risk of having a police contact, but who, at the same time, are the least apt to be studied. See *DELINQUENCY COHORT I*, *supra*

The final sample of 987 subjects consisted of 487 males and 500 females who were selected, according to certain criteria,²⁰⁵ to ensure two requirements: 1) that all subjects had remained in the city of Philadelphia from the time of their birth through age twenty-two, to prevent any dropout bias, and 2) that all subjects had complete data at each time point in the study, to prevent any bias due to missing data. The study used three primary data sources: 1) the Perinatal Project's data set of early biological and environmental factors; 2) school records; and 3) police records for juveniles and adults.

1. Early Biological and Environmental Factors

Data collection for the Biosocial Study was prospective, or looking to future events. Upon registration for the study, each mother underwent a battery of interviews and physical examinations. Data recorded for each pregnancy included information on the mother's reproductive history, recent and past medical history, prenatal examination and laboratory test results, all drugs taken during pregnancy, and labor and delivery events. Data recorded for each child included information on neurological examinations conducted at birth, throughout the hospital stay, at four months, and at one and seven years. Additionally, the children took speech, language, and hearing examinations at three and eight years. Researchers collected socioeconomic and family data during the mother's registration and the child's seven-year examination.²⁰⁶

2. School Reports

Philadelphia public school records contain a variety of data that complement the Perinatal Project data collected during the child's first

note 135, at 86-87.

²⁰⁵ These subjects were selected according to the following criteria: they (1) attended a Philadelphia public school, (2) stayed in Philadelphia from ages 10 through 17, (3) received selected intelligence tests within six months of age 7 and achievement tests at ages 13 and 14, and (4) were not among sibling members excluded from the sample to prevent possible biases in multiple family membership. Comparisons between the final sample of 987 subjects and the excluded sample of 2,158 black subjects showed no significant differences in key variables: total family income, per capita family income, the number of prenatal examinations attended by the mother, the mother's age, and the distribution of males and females. In general, the final sample appeared to be representative of the sample from which it was drawn.

²⁰⁶ Data were collected quickly and uniformly after an event occurred. Highly structured precoded forms and manuals were used to ensure comprehensiveness and comparability among the coders who recorded the data. All coders were either medical doctors or psychologists trained to record data systematically. For descriptions of the numerous procedures used to ensure reliability in the Project coding, see K. NISWANDER & M. GORDON, *supra* note 172, at 17-19, 500-24.

seven years. The Biosocial Study used two types of school record data for analysis: 1) academic achievement during ages thirteen and fourteen²⁰⁷ and 2) evidence of learning or behavioral disability during school attendance.²⁰⁸

3. Juvenile and Adult Police Records

The Biosocial Study collected official police records for all subjects for ages seven through twenty-two.²⁰⁹ The study used three different

²⁰⁷ The California Achievement Test measured academic achievement in grades seven and eight, attended during ages thirteen and fourteen. Social scientists have described the California Achievement Test as an excellent data source for measuring both verbal and mathematical achievement, and they have found a high correlation between that test and the intelligence tests conducted in the Perinatal Project at age seven. See Bryan, *California Achievement Tests*, in *THE EIGHTH MENTAL MEASUREMENTS YEARBOOK* 35-37 (O. Buros ed. 1978); Washington & Teska, *Correlations Between the Wide Range Achievement Test, the California Achievement Tests, the Stanford-Binet, and the Illinois Test of Psycholinguistic Abilities*, 26 *PSYCHOLOGICAL REP.* 291-94 (1970); Womer, *California Achievement Tests*, in *THE EIGHTH MENTAL MEASUREMENTS YEARBOOK*, *supra*, at 37-39. Achievement data for grades seven and eight were analyzed because they included measures of mathematical ability and because they were measured close to the onset of offense behavior. Thus, data at ages 13 and 14 provide "age of onset" ability measures rather than the "before age of onset" ability measures in the Perinatal Project data.

²⁰⁸ Evidence of learning and behavioral problems was measured by the presence, during adolescence, of any record of involvement in special school programs for those classified as mentally retarded or disciplinary problems. Children with disciplinary problems were diagnosed as having normal intellectual ability, but some record of asocial behavior in school, such as physical aggression toward teachers, fire starting, inability to adjust to school, and conduct disturbance. According to the Philadelphia School Board, recommendation of a child to a program for disciplinary problems was based solely on in-school performance and was made independently of any knowledge of a child's official delinquent status.

²⁰⁹ The advantages of using official police records for indicating delinquent behavior, compared to other points of contact in the juvenile justice system such as court trials, have been discussed elsewhere. See *DELINQUENCY COHORT I*, *supra* note 135, at 13-17. Most important is the relatively less biased nature of a police contact, as the first event in a long chain of official processing biases in the juvenile justice process. In general, there is also considerable evidence that the demographic and socioeconomic distributions of offenders designated by police contacts are similar to distributions in data gathered from other sources, such as self-reports or victimization data. See *Correlates of Delinquency*, *supra* note 174, at 998-1009. It is important to note, however, that the status, or characterization, of delinquency and adult crime in this study is based on total police contacts, not just arrests. Consequently, the delinquent sample includes a portion of adolescents who may self-report participation in an illegal event, but who may have only an official "remedial" status, which is recorded, but is not a formal arrest. Thus, although only official records are examined, they include a significant proportion of police contacts that may have been ignored in other delinquency research. A detailed description of the arrest data collection and coding procedure, the inter-coding reliability check, major variables, and offender categories is available. See Center for Studies in Criminology and Criminal Law, University of Pennsylvania, Collection and Coding of Offense Data for the Biosocial Project (Feb. 1981) (unpublished manuscript).

measures of delinquency and adult crime: 1) number of offenses; 2) categorization of delinquency offenders according to levels of the most serious offense recorded (nonindex, property, and violence);²¹⁰ and 3) seriousness of offenses.²¹¹

4. Theory Integration

Few studies have examined criminal behavior over individuals' life spans.²¹² Uniform Crime Report data show, however, considerable differences in the types and frequencies of arrests reported according to age: in general, juveniles between the ages of ten to eighteen are more likely to have a police contact for property offenses and relatively less serious crimes, while young adults between the ages of nineteen and twenty-five are more likely than juvenile offenders to have a police contact for violent and serious crimes.²¹³ Moreover, juveniles who display

²¹⁰ There are three types of offenders: violent, property, and nonindex. Violent offenders are those individuals who have had a police contact for at least one violent offense at any time during their juvenile criminal career. Violent offenses consist of murder, assault with intent to kill, aggravated assault, simple assault, rape, robbery with injury, and any other offense that involved injury to the victim. Property offenders have had at least one police contact for property-related offenses, but no history of violent offenses. Property-related offenses include vandalism, burglary, robbery without injury, and auto theft. Nonindex offenders are those who have had a police contact for at least one nonindex offense, but no history of violent or property-related offenses. Nonindex offenses comprise truancy, disorderly conduct, running away, fraud, and possession of alcohol, marihuana, or hard drugs.

²¹¹ Sellin and Wolfgang originally developed a detailed method of ranking and scoring offense seriousness. See T. SELLIN & M. WOLFGANG, *THE MEASUREMENT OF DELINQUENCY* 145-258 (1964). The current method involves assigning numerical weights to different components of an offense, such as level of injury, amount of property theft or damage, victim intimidation, premises entered, and vehicles stolen. The weights were developed from a national survey of crime severity. See M. WOLFGANG, R. FIGLIO, P. TRACY & S. SINGER, *THE NATIONAL SURVEY OF CRIME SEVERITY* 129-36 (1985). The seriousness score allows a more precise representation of offense seriousness than is reflected in the arrest code classification. It is also an excellent method of summarizing, in one score, the severity of an offender's delinquency record throughout adolescence.

²¹² See Sellin Center for Studies in Criminology and Criminal Law, the Wharton School, University of Pennsylvania, *Criminal Behavior over the Life Span: The Relationship of Juvenile Delinquency to Adult Criminal Behavior 1* (Feb. 27, 1987) [hereinafter *Life Span*] (unpublished manuscript); see also Wolfgang, Thornberry & Figlio, *Juvenile and Adult Criminal Careers*, in *FROM BOY TO MAN, FROM DELINQUENCY TO CRIME*, *supra* note 178, at 20, 25-32 [hereinafter *Juvenile and Adult Careers*] (discussing the collection and analysis of adult data for the original birth cohort project, *DELINQUENCY COHORT I*, *supra* note 135, which examined the criminal behaviors of all boys born in 1945 who continued to live in Philadelphia from ages 10 to 18).

²¹³ See F.B.I., U.S. DEP'T OF JUSTICE, *UNIFORM CRIME REPORTS*, 1984, at 172-73, 178, 188-90 (1985); see also Zimring, *American Youth Violence: Issues and Trends*, in *CRIME AND JUSTICE: AN ANNUAL REVIEW OF RESEARCH* 67, 72-73 (N. Morris & M. Tonry eds. 1979) (noting that 1975 crime data show that "property crimes are concentrated earlier in the adolescent years, while the aggregate category of

relatively more aggressive childhood behavior or commit delinquent offenses are more likely to be adult offenders than their less delinquent or nondelinquent counterparts.²¹⁴

Among both juveniles and adults, evidence indicates that only a small proportion of individuals is responsible for the great majority of police contacts. In a longitudinal study of a cohort of nearly 10,000 boys born in 1945 and living in Philadelphia from ages ten to eighteen,²¹⁵ for example, data showed that chronic offenders,²¹⁶ who constituted only six percent of the cohort and eighteen percent of the offenders, were responsible for over one-half of all the delinquent offenses committed by the cohort.²¹⁷ A later study of a birth cohort of Philadelphia boys²¹⁸ and other research conducted both nationally and internationally²¹⁹ replicate this finding. Similarly, a small group of adult offenders is responsible for most adult offenses.²²⁰ In turn, "[t]here is excellent evidence that some biological factors are especially useful in distinguishing chronic offenders."²²¹ Thus, the behaviors and characteristics of the chronic few are of particular importance from perspectives

crimes of violence peaks during ages 18-20"); *Juvenile and Adult Careers*, *supra* note 212, at 25-26 (finding that "offenses committed during the juvenile period were significantly less serious than those committed during adulthood").

²¹⁴ For research showing links between aggressive behaviors in childhood and later juvenile and adult crime, see D. WEST, WHO BECOMES DELINQUENT? 98-107, 168-85 (1973) (in collaboration with D. Farrington); Magnusson, Stattin & Duner, *Aggression and Criminality in a Longitudinal Perspective*, in PROSPECTIVE STUDIES OF CRIME AND DELINQUENCY 277, 277-301 (K. Van Dusen & S. Mednick eds. 1983); G. Spivak, High Risk Early Behaviors Indicating Vulnerability to Delinquency in the Community and School 135, 145-48 (Sept. 1983) (unpublished manuscript) (available at the Department of Mental Health Studies, Hahnemann University). For a thorough review of the studies showing a transition between juvenile and adult crime, see Life Span, *supra* note 212, at 50-55.

²¹⁵ See DELINQUENCY COHORT I, *supra* note 135, at 27.

²¹⁶ A "chronic offender" is defined in the study as an individual who has committed five or more offenses. *See id.* at 88.

²¹⁷ *See id.* at 247-48.

²¹⁸ See P. TRACY, M. WOLFGANG & R. FIGLIO, DELINQUENCY IN TWO BIRTH COHORTS: EXECUTIVE SUMMARY 9-10 (1985) [hereinafter DELINQUENCY COHORT II] (describing "chronic delinquency" as one of the study's most important findings).

²¹⁹ See, e.g., D. HAMPARIAN, R. SCHUSTER, S. DINITZ, & J. CONRAD, THE VIOLENT FEW: A STUDY OF DANGEROUS JUVENILE OFFENDERS 128-29 (1978) (finding a large degree of replication in Columbus, Ohio); Farrington, *Offending from 10 to 25 Years of Age*, in PROSPECTIVE STUDIES OF CRIME AND DELINQUENCY, *supra* note 214, at 17, 23-24 (noting similar results in England); Shannon, *A Longitudinal Study of Delinquency and Crime*, in QUANTITATIVE STUDIES IN CRIMINOLOGY 121, 122 (C. Wellford ed. 1978) (finding replication in Racine, Wisconsin).

²²⁰ See Life Span, *supra* note 212, at 5, 6; see also Farrington, *supra* note 219, at 23, 25 (discussing similar findings among adult offenders who had multiple juvenile offenses); *Juvenile and Adult Careers*, *supra* note 212, at 23-24 (discussing the frequency of offense behavior within a small group of adult offenders).

²²¹ Mednick, *supra* note 2, at 3.

of both social policy and criminal responsibility.

The initial set of nearly 150 measures in this study was selected according to social structural, social bonding, developmental, and biopsychological theories of delinquency and adult crime.²²² The integration of biological and sociological theories of behavior is a critical step toward understanding why crime occurs and its significance to matters concerning criminal responsibility. Based on the review of the literature in Part I of this Comment, delinquent or criminal status may depend, in part, on early developmental, biological, and environmental factors whose cumulative influences vary over time. For example, "at risk" infants, who have had prenatal or birth complications, may have somewhat more difficulty adjusting to poor environments than healthy, full-term infants. Moreover, such infants may also be more prone to later CNS-related disorders associated with juvenile and adult crime. However, the nature and extent of the effect of "at risk" factors on delinquent behavior are complex and, in many ways, difficult to detect. The opportunity to identify "cause-and-effect" relationships is an advantage of longitudinal research²²³ because the interrelationships among variables and the likelihood of crime are not always clear or consistent.

C. *Assessment of the Biological and Environmental Impact on Crime*

In their recent book, *Crime and Human Nature*, Wilson and Herrnstein point out the lack of information available in the social sciences on the complex interactions between biological and environmental variables and criminal behavior.²²⁴ Such information is necessary, according to the authors, in order to assess more appropriately both the roles of internal and external influences on behavior and issues of responsibility in the law. They suggest the need for a prospective study of individuals followed from birth through adolescence to unravel the ties between such "traits and circumstances" as constitution and social factors. They also emphasize the importance of longitudinal research on underprivileged children to determine the contributions of select social and environmental effects, including family and socioeconomic

²²² For a detailed description of these measures, see D. DENNO, *supra* note 201, app.

²²³ See Rubin & Balow, *Perinatal Influences on the Behavior and Learning Problems of Children*, in 1 ADVANCES IN CLINICAL CHILD PSYCHOLOGY 119, 121-25 (B. Lahey & A. Kazdin eds. 1977) (describing longitudinal research as an optimal methodology for studying the effects of perinatal complications).

²²⁴ See J. WILSON & R. HERRNSTEIN, *supra* note 1, at 41-43; see also N. MORRIS, MADNESS AND THE CRIMINAL LAW 62 (1982) (emphasizing that the effects of crime-causing factors must be tested empirically).

structure.²²⁵

The Biosocial Study attempted to unravel these influences and to examine individual theories of behavior.²²⁶ Interrelationships among the initial set of 150 measures as well as juvenile and adult crime were examined using a series of structural equation path models.²²⁷ Ultimately, one final model of relationships was produced. Overall, the results demonstrated that biological and environmental factors were significant influences on crime for both sexes, although biological factors appeared to have relatively more of an effect on females. For adult male and female offenders, the number and seriousness of juvenile offenses had the strongest predictive value; the number of disciplinary problems in school was also a very strong predictor for females, while low language achievement and mother's and father's low level of education were strong predictors for males. The total effect of the selected variables, exclusive of the intervening delinquency and achievement variables, differed for male and female subjects. Adult male offenses were most strongly influenced by relatively low levels of mother's and

²²⁵ See J. WILSON & R. HERRNSTEIN, *supra* note 1, at 478.

²²⁶ An in-depth discussion of the results, the variables that were analyzed, and the statistical models that were tested and applied is presented in D. DENNO, *supra* note 201.

²²⁷ Structural equation models have been found to be useful in many areas of the social and behavioral sciences, particularly for longitudinal data. They combine features of factor analysis and regression analysis. The models are especially appropriate for analyzing longitudinal panel data, because each equation represents a "causal link," in contrast to other techniques, such as ordinary least squares regression, in which each equation represents an empirical association. See Goldberger, *Structural Equation Models: An Overview*, in *STRUCTURAL EQUATION MODELS IN THE SOCIAL SCIENCES* 1, 2 (A. Goldberger & O. Duncan eds. 1973). Karl Jöreskog has developed a general linear model for the analysis of covariance structures that allows for both error in the equations and error in the variables. The general model is a system of equations relating unobservable and observable independent and dependent variables with an underlying causal structure. See Jöreskog, *Structural Equation Models in the Social Sciences: Specification, Estimation and Testing*, in *ADVANCES IN FACTOR ANALYSIS AND STRUCTURAL EQUATION MODELS* 105, 106-07 (J. Magidson ed. 1979).

In the Biosocial Study, the initial set of 150 measures was eventually reduced, using regression analysis, through a screen of the most statistically significant measures to a total of seven dependent variables and twenty-two independent variables across different ages. The seven dependent variables were verbal IQ, spatial IQ, disciplinary problems in school, language achievement, evidence of mental retardation, number of juvenile delinquent offenses, and number of adult offenses. The twenty-two independent variables were pregnancy and delivery conditions, mother's and father's education, family income measured at two times, amount of time the father was unemployed, hand preference tested at two times, eye and foot preference, Stanford-Binet Intelligence Scale test results, number of neurological abnormalities, abnormal movements, abnormal vision, lead intoxication, anemia, intellectual status, speech, whether the individual had been adopted, absence of the father, number of household moves, and number of persons supported in the household. For an in-depth description of the variables and their results, see D. DENNO, *supra* note 201.

father's education, high levels of lead intoxication, and the number of gaps in the father's employment history. Adult female offenses were most strongly influenced by father's absence and low education, number of neurological abnormalities, and the status of coming from a foster home. Thus, father's low education level had a significant effect on both male and female adult crime.

For males, juvenile crime was most strongly predicted by the number of a child's disciplinary problems by ages thirteen to fourteen, the amount of time the father was unemployed by the time his son reached age seven, and the presence of lead intoxication at age seven. Evidence of abnormal speech at age seven and low language achievement at ages thirteen to fourteen were significant, but showed considerably less of an effect. In turn, disciplinary problems were associated with factors indicative of attention deficit disorder and hyperactivity, such as lead intoxication, anemia, and left-handedness. Foster parent status and frequent household moves were less strongly related.

For females, juvenile crime was most strongly predicted by foster home status at age seven, the number of disciplinary problems at ages thirteen to fourteen, left foot preferences at age four, and the number of neurological abnormalities at age seven. Father absence from birth to age seven, language achievement at ages thirteen to fourteen, abnormal movements at age seven, and right eye preference at age four followed in decreasing order of magnitude. Disciplinary problems were significantly related to two neurological disorders: abnormal movements and abnormal vision at age seven.

Two predictors showed significant effects for both male and female juvenile crime: the number of childhood disciplinary problems and low language achievement in school during ages thirteen and fourteen. These results confirm past research that has highlighted the importance of behavior and ability in predicting delinquency.²²⁸ The present study, however, examined a number of variables that never before had been included in crime research, thus augmenting, in some respects, the list of established factors to be analyzed.

Results of the Biosocial Study did not confirm some past findings of direct relationships between delinquency and early intelligence,²²⁹ mental retardation,²³⁰ socioeconomic status,²³¹ and early central nervous system dysfunction as measured by the number of pregnancy complica-

²²⁸ See Loeber & Dishion, *Early Predictors of Male Delinquency: A Review*, 94 *PSYCHOLOGICAL BULL.* 68, 87-90, 94 (1983).

²²⁹ See *supra* notes 135-36 and accompanying text.

²³⁰ See *supra* notes 126-34 and accompanying text.

²³¹ See *supra* notes 174-81 and accompanying text.

tions.²³² The lack of strong, significant associations among these variables and juvenile and adult crime may be due to several factors: the cultural and demographic characteristics and homogeneity of the sample; the infrequent occurrence of some of the independent variables, such as pregnancy and delivery complications, which could cause underestimation of true associations; or the simultaneous analyses of both biological and environmental variables, which could negate more "traditional" findings.²³³

Results of the Biosocial Study do suggest, however, that biological and environmental variables exert strong and independent influences on juvenile crime. 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. Other research supports this conclusion. For example, studies have shown links among low school achievement, behavioral disturbance, and subsequent crime in intellectually normal children with attention deficit disorder (ADD), minimal brain dysfunction (MBD), and hyperactivity.²³⁴ Correlates of the ADD-MBD complex include central nervous system trauma, neurodevelopmental delay, soft neurological signs like mixed dominance, and poor environment.²³⁵

It appears that ADD-MBD and hyperactivity could be associated with the learning and behavioral disorders shown by some members of this study's sample. In turn, these problems would inhibit considerably the ability of young children to create social bonds even before beginning school. Academic failure would perpetuate misconduct and impede attempts at future, socially acceptable behavior. Indeed, a sizable literature shows that children displaying ADD-MBD and hyperactivity are more likely to retain antisocial conduct during adulthood,²³⁶ a time

²³² See *supra* note 144 and accompanying text.

²³³ For example, much of the research analyzing biological factors and crime has not used adequate controls for social, demographic, and environmental influences. Consequently, some past findings of biological links to intelligence or to crime may be the product of environmental effects. In turn, longstanding associations between environmental factors and crime may disguise the significance of biological effects, because they are rarely incorporated into delinquency research. Other variables, such as disciplinary problems, may be an outcome of both biological and environmental precursors, like neurological abnormalities and familial instability.

²³⁴ See *supra* notes 153-55 and accompanying text.

²³⁵ See *supra* notes 156-60 and accompanying text.

²³⁶ See, e.g., D. LEWIS & D. BALLA, *supra* note 135, at 69-70 (reporting that "children with early indications of central nervous system dysfunction, especially hyperactivity, may be at high risk not only for juvenile delinquency but also for serious adult maladaptive disorders"); J. WILSON & R. HERRNSTEIN, *supra* note 1, at 201-02 (reviewing studies showing that hyperactive children are more likely to commit crimes as adults than are nonhyperactive children).

when most individuals start to show commitments to socially desirable behavior.²³⁷ Studies of children demonstrating that more males than females have ADD-MBD and hyperactivity²³⁸ may also explain in part gender differences in the commission of crimes.

The Biosocial Study's model presented by this study provides an example for discussion of an overall view of prediction and causality in the criminal law. In light of past biological and environmental research, this model may also be applied to test different perspectives on the "free-will vs. determinism" debate in an effort to assess the feasibility of several proposed biological deficiency defenses.

III. BIOLOGICAL DEFICIENCY AS A CRIMINAL DEFENSE

A. *Predicting Behavior: Faulty Models or "Degree Determinism"?*

The preceding Part discussed the success with which selected biological and environmental factors predicted juvenile and adult crime. However, there is another way of looking at prediction: How well do all of these factors together predict behavior?

In a "perfect" prediction world, social scientists would be able to predict 100% of an individual's future behavior. No such world exists, however, particularly in the social sciences.²³⁹ In the present study, fairly comprehensive models of biological and environmental variables predicted twenty-five percent of future adult criminality among males and nineteen percent of future adult criminality among females. These percentages are statistically significant, and they offer an acceptable level of predictability; however, seventy-five to eighty percent of behavior is left unexplained. Moreover, past behavior, such as juvenile crime,

²³⁷ See Comment, *Rehabilitation as the Justification of a Separate Juvenile Justice System*, 64 CALIF. L. REV. 984, 1011 (1976).

²³⁸ See Belmont, *Epidemiology*, in HANDBOOK OF MINIMAL BRAIN DYSFUNCTIONS, *supra* note 152, at 55, 58-62, 66-69.

²³⁹ The ability to predict is a problem for most research. For example, the link between cigarette smoking and lung cancer is strong enough to stop many individuals from smoking and is sufficiently independent of other variables to lead researchers to label it "causation." See U.S. DEP'T OF HEALTH EDUCATION AND WELFARE, SMOKING AND HEALTH: REPORT OF THE SURGEON GENERAL 5-9 to 5-23 (1979) (monthly catalogue no. 79-15236). Nevertheless, the status of being a smoker does not provide a highly substantial ability to predict whether the individual will eventually get cancer, because most people, whether smokers or not, do not get lung cancer and eventually die of some other cause. See BUREAU OF THE CENSUS, U.S. DEP'T OF COMMERCE, STATISTICAL ABSTRACT OF THE UNITED STATES 1988, at 77. The same sort of problem exists in trying to predict social phenomena. Cf. Gross, *Race and Death: The Judicial Evaluation of Evidence of Discrimination in Capital Sentencing*, 18 U.C. DAVIS L. REV. 1275 (1985) (discussing the relationship between race and imposition of the death penalty).

was the strongest predictor of future adult criminal behavior.

There are two ways of regarding this result. First, those who support the philosophy of "full determinism" could argue that perfect prediction of behavior is possible, but social scientists are aware of only a portion of the determining factors even with a fairly comprehensive model.²⁴⁰ Those who support full determinism would denounce the use of social science research to justify a biological deficiency defense because there may be other, comparably severe deficiencies that are not yet known to social scientists or have simply been left out of the scientists' models. According to Moore,

[i]f we truly believe that all behavior is fully determined and that fully determined behavior is not the actor's responsibility, it would be immoral to hold people responsible because we were ignorant of what caused them to act. To say otherwise would be tantamount to excusing those who have some particular excuse about which we have knowledge, but holding all others responsible because we are ignorant of what excuse they have — even though we believe that all of those others have some valid excuse.²⁴¹

Taking Moore's position to the extreme, one could argue that all behavior could be excused or defended if we simply locate the causing factors. Such an argument leads to the "absurd conclusion that no one is responsible for anything"²⁴² and, therefore, no one can be punished.

A second way of viewing the predictive weakness of current models is "degree determinism," which Moore criticizes,²⁴³ but does not adequately replace. As defined by one commentator, degree determinism is the "degree of freedom of choice on a continuum from the hypothetically entirely rational to the hypothetically pathologically determined—in states of consciousness neither polar condition exists."²⁴⁴ Thus, varying degrees of free will and determinism exist in all actions depending, of course, on such factors as biological and environmental forces. With regard to criminal responsibility, we must ask the following: at what point does behavior so approach the determinism end of the continuum that it may be considered outside of an individual's control and, therefore, nonblameworthy? When, in other words, does responsibility end and excuse begin?

²⁴⁰ This perspective is a modification of that discussed in Moore, *supra* note 191, at 1118-19.

²⁴¹ *Id.* at 1119.

²⁴² *Id.* at 1092.

²⁴³ *See id.* at 1114-18.

²⁴⁴ N. MORRIS, *supra* note 224, at 61.

The degree determinists offer different answers. According to Morris, for example, the question should be tested empirically. However, without any empirical support, he makes the assumption that external pressures, such as "social adversity," are much more influential in encouraging crime than internal pressures, such as psychosis, and concludes that excuses in the criminal law such as the insanity defense should be abolished.²⁴⁵ He argues that such excuses give "excessive weight to the psychological over the social."²⁴⁶ Bazelon, on the other hand, agrees with Morris's emphasis on both internal and external effects, but would extend, rather than constrict, the scope of legal excuses.²⁴⁷ He would instruct the jury, for example, to consider testimony on "the nature and extent of behavioral impairments and of physiological, psychological, environmental, cultural, educational, economic, and heredity factors" in determining whether a defendant can "justly be held responsible for his act"; this instruction would have the "ultimate aim . . . to give all of us a deeper understanding of the causes of human behavior in general and criminal behavior in particular."²⁴⁸

But would it? A discussion of the proper standards for the admission of certain evidence, including expert testimony, is beyond the scope of this Comment. However, the review and critique of research in Part I of this Comment and the empirical study in Part II demonstrate that any firm conclusions regarding the validity or reliability of scientific research on behavior are unwarranted.²⁴⁹ Moreover, the research has not justified presumptions of cause-and-effect relationships.

B. *The Fictions of Free Will and Cause in the Criminal Law*

Two other issues further complicate the arguments concerning degree determinism or determinism in general: the fictions of free will and cause in the criminal law. The free-will fiction is best character-

²⁴⁵ See *id.* at 61-64.

²⁴⁶ *Id.* at 64.

²⁴⁷ See Bazelon, *The Morality of the Criminal Law*, 49 S. CAL. L. REV. 385, 395-98 (1976). But see Morse, *The Twilight of Welfare Criminology: A Reply to Judge Bazelon*, 49 S. CAL. L. REV. 1247, 1254 (1976) (arguing that Bazelon's proposal to include a broad range of factors in any nonresponsibility defense "is improper unless there is a social consensus that the relevance of any and all [such] factors . . . should be decided independently by every jury").

²⁴⁸ Bazelon, *supra* note 247, at 396.

²⁴⁹ Morse makes a comparable argument against broadening the group of factors or individuals to be considered for special criminal law defenses. "Courts and legislatures should do so only if there is broad social consensus for such a change or if the scientific evidence on behavioral choice seems clear." Morse, *supra* note 247, at 1267.

ized by Herbert Packer:

The idea of free will in relation to conduct is not, in the legal system, a statement of fact, but rather a value preference having very little to do with the metaphysics of determinism or free will . . . Very simply, the law treats man's conduct as autonomous and willed, not because it is, but because it is desirable to proceed as if it were.²⁵⁰

Moore is correct in stating that Packer's fictional account of the law "cannot possibly work."²⁵¹ However, one of Moore's alternative explanations²⁵² appears to be more of a variation on the theme of degree determinism than any "new" theory of behavior: "[P]eople can exercise their will even though their actions are caused. People do not need to stand outside the causal order . . . in order to exercise those causal powers that are the essence of human actions."²⁵³ Thus, free will exists in conjunction with causal agents.

The apparent conflicts concerning philosophies of behavior may in reality be conflicts regarding notions of causality. "Cause" in the criminal law has become a bankrupt term that is made most apparent by those criminal law defenses that attempt to stress direct links between biological and environmental events and criminal behavior.²⁵⁴ "Cause" in the social sciences is an illusion.²⁵⁵ A more acceptable social science approach is to predict behavior in terms of a series of probabilities that certain events will result in an expected outcome.

C. *A Probability Theory of Behavior*

The empirical models discussed in this Comment apply a probability theory of behavior. Such a theory is consistent with both the theory of degree determinism and with the probabilistic theories of behavior suggested by others.²⁵⁶ For example, the Biosocial Study empirically tested Morse's focus on the relative strength of the many possible

²⁵⁰ Moore, *supra* note 191, at 1122 (quoting H. PACKER, *supra* note 3, at 74-75). See generally D. DENNETT, *ELBOW ROOM* (1984) (discussing free-will issues in the criminal law).

²⁵¹ Moore, *supra* note 191, at 1122.

²⁵² Moore concludes that "[i]t is not obvious that there must be a single theory of all the excuses." *Id.* at 1148. However, Moore's critique of the theories held by others is clearer than the alternative theories he recommends.

²⁵³ *Id.* at 1140.

²⁵⁴ See *infra* notes 276-84 and accompanying text.

²⁵⁵ See *supra* notes 190-200 and accompanying text.

²⁵⁶ See N. MORRIS, *supra* note 224, at 61; Moore, *supra* note 191, at 1116; Morse, *Crazy Behavior, Morals, and Science: An Analysis of Mental Health Law*, 51 S. CAL. L. REV. 527, 564-66 (1978); Morse, *supra* note 5, at 1031.

factors associated with behavior.²⁵⁷

An International Conference on Crime presented a more general characterization of the dynamics of a probability theory that explained criminal behavior as a probabilistic model incorporating three general categories of variables: predisposing, facilitating, and inhibiting.²⁵⁸ Predisposing variables were defined as "having a necessary but not sufficient or compelling relationship with the phenomena being studied."²⁵⁹ Their presence increases the likelihood of, and may account for, a significant portion of criminal behavior.²⁶⁰ Such variables include genetic, psychophysiological, neurological, and social influences.²⁶¹ Facilitating variables "do not by themselves explain or cause the phenomena in question but, in combination with the predisposing variables they increase the probability that the behavior will occur."²⁶² These factors include the use of drugs and alcohol, victim provocation, the availability of weapons, and the environmental and social context of the situation.²⁶³ Inhibiting variables "are those which, in the presence of predisposing factors, tend to decrease the probability that the behavior in question will occur and they may even prevent the behavior from occurring at all."²⁶⁴ For example, the internalization of social-ethical norms, autonomic nervous system factors such as fear and guilt, the desire to avoid punishment, high intelligence, and socialization in acceptable behavior may have a deterrent effect on criminality.²⁶⁵

As is apparent, some variables may belong in more than one category, depending on an individual's status. Low achievement level, as was shown in Part II of this Comment, is a predisposing variable bearing a strong relation to future criminality; high achievement level could then be considered a strong inhibiting variable. This model fits with a theory of degree determinism because where individuals fall on the free will/determinism continuum depends on a variety of constraining and

²⁵⁷ See Morse, *supra* note 5, at 1031-33.

²⁵⁸ This probabilistic model was suggested by Professor Wouter Buikhuisen as a method of categorizing a number of variables for the international and interdisciplinary study of causal factors related to criminality. The model was approved and expanded by the International Interdisciplinary Group during its Brazil Workshop in November, 1976. See Report of the Interdisciplinary Group on Criminology 5-6 (1978) (unpublished manuscript) (on file at the Sellin Center for Studies in Criminology and Criminal Law, the Wharton School, University of Pennsylvania).

²⁵⁹ *Id.* at 5.

²⁶⁰ See *id.*

²⁶¹ See *id.*

²⁶² *Id.*

²⁶³ See *id.*

²⁶⁴ *Id.*

²⁶⁵ See *id.*

inhibiting factors.²⁶⁶

D. *Probability Theory, Responsibility, and Criminal Law Defenses*

The greatest difficulty in assessing a theory of behavior comes in determining the point at which individuals are no longer considered responsible for their actions. This issue concerns more than just an individual's culpability; it affects as well our concept of "distributive justice."²⁶⁷ That concept includes the benefits and burdens of personal freedom and responsibility in society,²⁶⁸ our notions of mens rea,²⁶⁹ and our attitudes toward the acceptance of defenses other than insanity, such as the defense of diminished capacity.²⁷⁰ The issue is also particularly difficult because the dividing line between who is or is not responsible is not clearly defined,²⁷¹ unlike arbitrary dividing lines in the law such as the criterion of age for distinguishing between juveniles and

²⁶⁶ This conclusion is supported by the research presented in this Comment as well as by extensive longitudinal research conducted on the Hawaiian Island of Kauai. See Goleman, *Thriving Despite Hardship: Key Childhood Traits Identified*, N.Y. Times, Oct. 13, 1987, at C1, col. 1.

²⁶⁷ The notion of distributive justice is discussed extensively in J. RAWLS, *A THEORY OF JUSTICE* (1971).

²⁶⁸ One perspective on the distribution of benefits and burdens in the context of criminal law philosophy is presented by Spjut, *The Relevance of Culpability to the Punishment and Prevention of Crime*, 19 AKRON L. REV. 197, 202 (1985) ("[T]he criminal law effects a limited, but important form of distributive justice, that is, an increment of security of freedom from interference by others with goods already distributed like life, bodily integrity and property.").

²⁶⁹ For a recent discussion of proposed changes in the concept of intention in English law, see Note, *Criminal Intention—A New Definition?*, 48 MOD. L. REV. 717, 720-23 (1985); see also Baker, *Mens Rea, Negligence and Criminal Law Reform*, 6 L. & PHIL. 53, 53-58 (1987) (criticizing the mens rea proposals presented by the Law Reform Commission of Canada).

²⁷⁰ A summary of arguments for and against the doctrine of diminished capacity may be found in Dressler, *Reaffirming the Moral Legitimacy of the Doctrine of Diminished Capacity: A Brief Reply to Professor Morse*, 75 J. CRIM. L. & CRIMINOLOGY 953, 955-60 (1984); see also Morse, *Undiminished Confusion in Diminished Capacity*, 75 J. CRIM. L. & CRIMINOLOGY 1, 38-50, 51-55 (1984) (arguing that, as a matter of constitutional law and fairness to defendants, the diminished capacity doctrine should be adopted to the extent that, as evidence of mental abnormality, it disproves the existence of mens rea).

²⁷¹ A few researchers have found characteristics distinguishing, for example, sane and insane killers. See, e.g., Packer, *supra* note 4, at 33-35 (reporting that homicide defendants found not guilty by reason of insanity were more prone to have had a psychiatric history prior to the homicide, to have received a diagnosis of a psychosis, and to have killed a family member than those found criminally responsible). In general, however, the criteria used for such distinctions are vague. See, e.g., Boyle & Baughman, *The Mental State of the Accused: Through a Glass Darkly*, 65 MICH. B.J. 78, 80 (explaining that, because neither the *M'Naghten* plus irresistible impulse test nor the *Durham* test was sufficiently precise, the Model Penal Code formulated a new test that clarified the standards under which the defense of insanity could be raised).

adults.²⁷²

A number of arguments exist, however, for considerably delimiting, or even eliminating, those criminal law defenses that could extend beyond the insanity defense.²⁷³ The insanity defense succeeds in an estimated two percent of criminal cases.²⁷⁴ In general, biological deficiency defenses that have no place under the insanity defense have an uncertain place in the criminal law.²⁷⁵ However, jurisdictions throughout the country vary in their acceptance of such defenses. Some attempted defenses include biological (genetic) deficiency,²⁷⁶ automatism,²⁷⁷ amnesia,²⁷⁸ Vietnam Stress Syndrome,²⁷⁹ brainwashing,²⁸⁰ severe environmental deprivation,²⁸¹ cultural differences,²⁸² battered woman's syndrome,²⁸³ and premenstrual syndrome.²⁸⁴

²⁷² The particular age for deciding when an individual is considered a juvenile or an adult is, of course, highly controversial. The point, however, is that age is a definite criterion, but "mental state" or "culpability" is not.

²⁷³ Consideration of whether or not the insanity defense itself should be abolished is beyond the scope of this Comment. However, the complications involved in determining who should receive the insanity defense are relevant to the arguments against other types of defenses. *See, e.g.*, Boyle & Baughman, *supra* note 271, at 85-86 (discussing the problems involved in determining the mental states of defendants with regard to the insanity defense); Daniel, Beck, Herath, Schmitz & Menninger, *Factors Correlated with Psychiatric Recommendations of Incompetency and Insanity*, 12 J. PSYCHOLOGY & L. 527, 542 (1984) (citing a "need to acknowledge that inherent difficulty in using psychological and psychiatric phenomena to make judgements regarding such fundamentally legal/moral/ethical constructs as competency and responsibility").

²⁷⁴ A review of the few efforts to gather data on the frequency of the use of the insanity defense can be found in Boehnert, *Psychological and Demographic Factors Associated with Individuals Using the Insanity Defense*, 13 J. PSYCHOLOGY & L. 9, 9 (1985). Another estimate is that "the insanity defense is invoked in far less than one percent of all felony cases." *See* Fentiman, *supra* note 16, at 601.

²⁷⁵ *See* Note, *Chromosome Defense*, *supra* note 26, at 912-13.

²⁷⁶ *See, e.g.*, Skeen, *The Genetically Defective Offender*, 9 WM. MITCHELL L. REV. 217, 263-65 (1983) (concluding that courts should be more open to genetic defenses in the future if trial attorneys are more knowledgeable and prepared).

²⁷⁷ *See* Lederman, *Non-Insane and Insane Automatism: Reducing the Significance of a Problematic Distinction*, 34 INT'L & COMP. L.Q. 819, 823-33 (1985).

²⁷⁸ *See* Hermann, *Criminal Defenses and Pleas in Mitigation Based on Amnesia*, 4 BEHAV. SCI. & L. 5, 5-8 (1986).

²⁷⁹ *See* Comment, *Vietnam Stress Syndrome and the Criminal Defendant*, 19 LOY. L.A.L. REV. 473, 475-78 (1985) [hereinafter Comment, *Vietnam Stress*].

²⁸⁰ *See* Comment, *Brainwashing: Fact, Fiction and Criminal Defense*, 44 UMKC L. REV. 438, 460-61 (1976).

²⁸¹ *See* Delgado, "Rotten Social Background": *Should the Criminal Law Recognize a Defense of Severe Environmental Deprivation?*, 3 L. & INEQUALITY 9, 12-23 (1985).

²⁸² *See* Note, *The Availability of the "Cultural Defense" as an Excuse for Criminal Behavior*, 16 GA. J. INT'L & COMP. L. 335, 352-54 (1986); Note, *The Cultural Defense in the Criminal Law*, 99 HARV. L. REV. 1293, 1311 (1986).

²⁸³ *See* Note, *Battered Woman's Syndrome and Premenstrual Syndrome: A Comparison of Their Possible Use as Defenses to Criminal Liability*, 59 ST. JOHN'S L. REV. 558, 587 (1985).

²⁸⁴ *See id.* at 587; *see also* Comment, *Premenstrual Syndrome as a Criminal*

As Parts I and II of this Comment demonstrate, the primary argument against including such defenses in the criminal law is that no strong evidence suggests that these factors totally impair free will or directly "cause" the crime. For example, during extensive preparations for *People v. Santos*,²⁸⁵ the prosecution found no scientific link between the premenstrual syndrome and crime.²⁸⁶ Moreover, if the defense factor is experienced by a sizable portion of the general population, it may carry less weight in the mind of a jury. For example, Michael Deaver gambled in using alcoholism as a perjury trial defense because it was likely that the jury would not be convinced that his alcohol and drug use contributed to his amnesia.²⁸⁷ On the other hand, a jury held Dan White unable to tell right from wrong because of mood swings and considerable stress.²⁸⁸ This result, however, spurred considerable anger and doubt about the court's ability to assess criminal responsibility.²⁸⁹

Second, in line with Moore's argument²⁹⁰, if courts allowed every possible defense for behavior, so that no one was responsible for anything then, because biological factors are more likely to be associated with violent crime,²⁹¹ the most serious and violent offenders would be deemed not culpable and only the less serious offenders would continue to be punished. Dangerous individuals would go "free," whether literally or in terms of a mitigated sentence, while the less serious offenders were incarcerated.²⁹² For example, in a recent study of fifteen death row inmates, a medical team found that all fifteen "had histories of severe head injury, five had major neurological impairment, and seven others had other, less serious neurological problems (e.g., blackouts, soft

Defense: The Need for a Medico-Legal Understanding, 15 N.C. CENT. L.J. 246, 255-58 (1985) (noting the acceptance of the PMS defense in England). *But see* Holtzman, *Premenstrual Symptoms: No Legal Defense*, 60 ST. JOHN'S L. REV. 712, 712-15 (1986) (harshly criticizing the PMS defense).

²⁸⁵ No. 1KO46299 (Kings County, N.Y. Crim. Ct. Nov. 3, 1982); *see also supra* notes 103-05 (discussing *Santos*).

²⁸⁶ *See* Holtzman, *supra* note 284, at 713.

²⁸⁷ *See* Shenon, *Deaver Cites Alcoholism as Perjury Trial Defense*, N.Y. Times, Oct. 3, 1987, at 7, col. 3. In fact, the defense caused the judge to give Deaver a lighter sentence, although he and the jury believed that Deaver knew his answers were false. *See* Shenon, *Deaver is Sentenced to Suspended Term and \$100,000 Fine*, N.Y. Times, Sept. 24, 1988, at 1, col. 4, 7, col. 2.

²⁸⁸ *See supra* note 12 and accompanying text.

²⁸⁹ *See* Szasz, *Dreyfus Redux, in Reverse*, N.Y. Times, Aug. 4, 1979, at 19.

²⁹⁰ *See* Moore, *supra* note 191, at 1092 (stating that, if behavior is caused, rather than chosen, then "no one is responsible for anything").

²⁹¹ *See Biology and Violence, supra* note 1, at 22.

²⁹² The irony of this situation was pointed out to me in a discussion with Park Dietz, Professor of Law and of Behavioral Medicine and Psychiatry, School of Law, University of Virginia.

signs).²⁹³ Although such a high incidence of disorders may be open to question, the authors' suggestion that such characteristics be considered in mitigating death sentences²⁹⁴ is convincing only if the alternative for such individuals would be incapacitation. Otherwise, considerably lesser sentences for these very serious offenders could be considered not only unfair, but a potential danger to society.

A third argument against extending the application of criminal law defenses is political. Regardless of an individual's opinions or orientation, particular defenses may be more appealing to some than to others, and juries or judges may respond more to personal values than to the actual evidence linking a defense to the criminal behavior. For example, Vietnam Stress Syndrome is a term applied to Post-traumatic Stress Disorder (PTSD) suffered by some veterans as a result of their experiences in the Vietnam War.²⁹⁵ PTSD is new and often misdiagnosed.²⁹⁶ However, even though it has not been a successful defense in most criminal cases,²⁹⁷ it has succeeded as a mitigating factor in sentencing,²⁹⁸ and it appears to be easier to fabricate than traditional mental illnesses.²⁹⁹ Defendants who claim other types of defenses that cannot be easily fabricated or that do not elicit the same degree of sympathy as the Vietnam experience could argue that the jury assesses politics rather than behavior.

A fourth argument against a biological deficiency defense returns to the issue of free will. According to some commentators, for example, neither mentally retarded³⁰⁰ nor mentally ill³⁰¹ offenders should be considered less culpable for their acts, because most are responsible, rational, and nondangerous. Their status does not negate their free will and thus does not warrant different treatment.

A fifth argument closely follows. In the same way that the mere status of being an alcoholic was held not to be a crime in *Robinson v.*

²⁹³ Lewis, Pincus, Feldman, Jackson & Bard, *Psychiatric, Neurological, and Psychoeducational Characteristics of 15 Death Row Inmates in the United States*, 143 AM. J. PSYCHIATRY 838, 838 (1986).

²⁹⁴ See *id.*

²⁹⁵ See Comment, *Vietnam Stress*, *supra* note 279, at 475-77.

²⁹⁶ See *id.* at 477.

²⁹⁷ See *id.* at 487-95.

²⁹⁸ See *id.* at 500-04.

²⁹⁹ Cf. *id.* at 506 (describing Vietnam Stress Syndrome as more believable than an insanity defense, not requiring a predisposition to mental illness, and more "understandable" to the jury).

³⁰⁰ See Menninger, *Mental Retardation and Criminal Responsibility: Some Thoughts on the Idiocy Defense*, 8 INT'L J.L. & PSYCHIATRY 343, 357 (1986).

³⁰¹ See Mitchell, *Culpable Mental Disorder and Criminal Liability*, 8 INT'L J.L. & PSYCHIATRY 273, 273 (1986).

California,³⁰² the status of "having a biological deficiency" should not be an automatic defense or a mitigating factor in any case in which it is offered. There is a tendency for legal commentators and researchers to confuse status with association to a criminal event.³⁰³ For the most part, judges and juries have rejected such a link between biological deficiency and criminal behavior.³⁰⁴

Such considerations, along with the Biosocial Study results presented in this Comment, support the adoption of an "all-or-none test of criminal responsibility" as suggested by Morse.³⁰⁵ Under this test, a small percentage of insane individuals only would be considered not guilty and those afflicted with less serious disorders would have a criminal responsibility equivalent to their sane peers. Not only would this system be more "fair," but it would appear more closely tied to the reality of human behavior, the little we know of it.

IV. THE CRIMINAL JUSTICE SYSTEM: A PHILOSOPHY OF ERRORS?

If biological and environmental factors should have a limited role in criminal law defenses, should they have any effect on sentencing? On one hand, it can be argued that such factors diminish an individual's culpability because they decrease behavioral control. On the other hand, such factors suggest that an individual has a greater likelihood of future harm to society and should therefore be incapacitated. The tension between individual freedom and social protection or responsibility is perhaps greatest when assessing culpability.

If one were to ask a roomful of experts in the area of biology and crime whether certain severe behavioral disorders actually "cause" crime, or whether the person suffering from a disorder truly had less culpability, there would be nearly total consensus that these are philosophical, not legal or factual, questions.³⁰⁶ This perspective reflects in part the realization that scientific evidence has yet to demonstrate anything more than propensities toward criminality. Unfortunately, there is no clear criminal justice or sentencing philosophy in the United States, a trend that appears likely to continue for some time.³⁰⁷

This difficulty is compounded further by what is perhaps a minor-

³⁰² 370 U.S. 660 (1962).

³⁰³ See *supra* notes 190-97 and accompanying text.

³⁰⁴ See *supra* notes 7-16 and accompanying text.

³⁰⁵ Morse, *supra* note 270, at 34.

³⁰⁶ For the opportunity to ask such questions, I thank Marvin E. Wolfgang and members of the Biology and Crime Group at the Sellin Center for Studies in Criminology and Criminal Law, the Wharton School, University of Pennsylvania.

³⁰⁷ See Robinson, *A Sentencing System for the 21st Century?*, 66 TEX. L. REV. 1, 1-5 (1987).

ity perspective: society should be held accountable in part for certain crime-causing factors that could have been prevented. Delgado further explains this "societal fault model":

In the societal fault model, the defendant is partially exonerated because he or she is able to show that the RSB [rotten social background] conditions that resulted in his or her act are chargeable to society. The jury would be instructed, as they are in negligence cases in some jurisdictions, to determine the proportion of individual and societal fault The defense would be limited to cases in which the defendant can prove that specific social institutions, such as schools, failed to discharge a duty to the defendant, resulting in his or her commission of a criminal offense.³⁰⁸

Once again, however, the issue returns to proof. The Biosocial Study discussed in Part II of this Comment showed that lead intoxication at an early age had a highly significant association with adult criminality. One might argue that lead intoxication, unlike, for example, the choice to drink alcohol, is not even initially voluntarily induced. Moreover, society could be blamed for the harmful levels of lead in certain homes. On the other hand, the societal fault model could have the consequence of mitigating the sentences of those individuals who pose the greatest threat to society. It would place the burden of societal fault on the future victims of unincarcerated offenders. Certain "hybrid proposals" offer possible solutions to this dilemma by providing a criminal justice philosophy that would account for both society's need to incapacitate and the individual's need for rehabilitation or fair treatment.³⁰⁹

This Comment leaves open an additional issue. Given the weak and unreliable links between human biology and criminal responsibility, is there any place for social science research in the criminal law? The answer depends upon what the research is attempting to show and what level of proof is required. Until social science research is greatly improved, it should have only a limited role in making judgments concerning criminal responsibility.

Social science research, however, can be and has been an excellent resource in other areas in which the issues are more defined and the demand for proof is less stringent. Differences in the type of sanction,

³⁰⁸ Delgado, *supra* note 281, at 89 (footnotes omitted).

³⁰⁹ "Rehabilitative incapacitation" may be one such proposal. *Cf.* Robinson, *supra* note 307, at 6-8 (arguing for adoption of a "distributive principle" that defines the relationship between punishment, deterrence, incapacitation, and rehabilitation).

rather than its length or certainty, might properly be influenced by such research. For example, a number of studies have demonstrated strong evidence of racial bias in sentencing and in the administration of the death penalty.³¹⁰ Consistent evidence of racial or other "extra-legal" bias in the administration of the most severe sanction in the criminal law might justifiably alter sentencing policy.

Thus, this Comment intends to encourage, not indict, the contributions of social science research. At the same time, however, a certain level of restraint is necessary so that what may be deemed a contribution in one area does not become a source of fiction in another.

³¹⁰ For a review of this research in the context of evidence of geographic and racial bias in the admission of the death penalty in New Jersey, see Bienen, Weiner, Denno, Allison & Mills, *The Reimposition of Capital Punishment in New Jersey: The Role of Prosecutorial Discretion*, 41 RUTGERS L. REV. 1, 66-124 (1988).

