Foreword: The Brain Sciences and Criminal Law Norms

by Theodore Y. Blumoff

\( \psi = f(\Phi) \)

Few would dispute the proposition that... social cognition, emotion, and behavior (\( \psi \)) emanate from the brain (\( \Phi \)).

INTRODUCTION

In general, researchers hope to answer the same ontological question: “Who are we?” Practitioners address the question in their own unique ways, employing the rhetoric and idioms, and the agenda and metrics, that express their respective domains. Researchers in the various brain sciences work at the frontier of knowledge about our brains, the final material cause of all of our endeavors. They fully share the commitment to this fundamental question. From the perspective of the brain sciences, the answer to this question—though certainly not now and

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1. John T. Cacioppo et al., Just Because You're Imaging the Brain Doesn't Mean You Can Stop Using Your Head: A Primer and Set of First Principles, 85 J. PERSONALITY & SOC. PSYCHOL. 650, 650 (2003) (discussing the basics of imaging and summarizing the work of James, Spencer, and Gordon Allport that shifted the paradigm for thinking about the source of human behavior in many of its most important aspects).
perhaps never fully elaborated–is nonetheless more widely understood than at any time in human history. We know at least this with certainty: Everything—everything—we perceive, know, feel, and sense emanates from the brain. Much of the new data affirm our sense of self. But some do not. We should look into those matters and take seriously the observation of Robert Sapolsky, who notes that many of the findings from neuroscience “must challenge our sense of self.”

This Article, which introduces Mercer’s 2010 Symposium edition, reports on some of the possibilities—and some of the dreams—from the research that supports the assertion that we should take cognizance of this new knowledge of ourselves. Others will share information about the admissibility of imaging evidence, about its potential for teasing out invisible biases, about the use of fMRI technology to determine some of the neural correlates of behavior, about the potential of neuroscientific data to unlock some of the hidden bases of our norms, and, finally, about the tricky use of imaging evidence to mitigate punishment in the death penalty context. Other articles will try to bring us up to date on the many advances in the brain sciences and present a somewhat skeptical approach to the law and neuroscience projects.

This report is mostly descriptive, reflecting the basic nature of the brain sciences, but it is not entirely descriptive. The modest normative claim made is that we should review some of the new findings from the brain sciences with a willingness to ask whether they belong in discussions about the sources that inform our normative discussions about criminal law and punishment. This Symposium will bring some of these questions into greater public focus. I am, of course, convinced that findings from the brain sciences do belong in these conversations. Bringing this data into the discussion will require us to take into account more fully than we do now the limitations that many among us are condemned to suffer. This addition to our conversation should conduce to greater compassion in criminal law, which is, and will always be, good for us as a polity.

What neuroscience tells us, in the broadest terms, is that measurements taken by the best available technology on virtually every capacity and condition that our genotype is capable of expressing provide many

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2. Robert M. Sapolsky, The Frontal Cortex and the Criminal Justice System, 359 PHIL. TRANSACTIONS ROYAL SOC’Y LONDON B. 1787, 1787 (2004) (emphasis added) (arguing that damage to the prefrontal cortex can produce individuals who know the difference between right and wrong and are, nonetheless, “organically incapable of appropriately regulating their behaviour”).
useful insights into the answer to this basic ontological question. From this perspective—generously defined to include neuroscience, neuropsychology, behavioral genetics, evolutionary psychology, cognitive psychology, and genetic ecology—many traits are graphically distributed as a bell-shaped curve. The implications of that distribution, from a policy perspective, are not now fully satisfied in our criminal law.

As a metaphor, the standard distribution graph is often associated—and justly—with racial animus, and it is, for this reason, rightly derided. We have tended to politicize the questions we ask of our genotypes. My own view is to urge care in the short term, to be cautiously optimistic in the mid term, and very optimistic in the long run. The last part of our brain to develop—the cerebral cortex—is far more contemplative than the early parts—the mechanisms of our “fight or flight” survival ontogeny. And our commitment to compassion is a lagging development.

Although the phrase “bell-shaped curve” is initially off-putting, its misuse in the past is obviously not predictive. The standard distribution, when applied to the human genome, is shorthand for the dispersal of many varied mechanisms and processes that generate the many midpoints along continua that define our human capacities. It is especially explanatory for angry, heinous crimes. Differences in functions as widely varying as nano-quantities of neurotransmitters and hormones that flow through our brains and blood streams seem to generate unwelcome conduct as a function of post-birth exposure to exceptionally harsh conditions. Thus, some among us will necessarily fail to meet our social norms. Vitally, though, we have the power to effect some shifts in the distributive midpoints of our various capacities toward a more compassionate and progressive direction; this direction could raise the capacities of the least well-off among us, along with everyone else.

6. If this sounds like an effort to combine Rawlsian thinking with contemporary neuroscience, it does so because it is such an effort. See, e.g., Theodore Y. Blumoff, An Essay on Liberalism and Public Theology, 14 J.L. & RELIGION 229 (1999-2000).
If this assessment is even approximately accurate, then we should think seriously about Sapolsky’s observation and, when appropriate, propose challenging new ideas in response to it. Individuals who support the findings from the various disciplines that constitute the brain sciences seem to bear a burden of expression, one committed to refocusing public discourse. To that end, at least four basic questions merit our consideration. First—the principal subject of this Article—what do we know about the relationship between intentional harmful actions and genetic/neurobiological deficiencies? Second, if some among us are condemned to suffer neurobiological and behavioral deficits, are they also susceptible to socially desirable rehabilitative interventions? If so, what are those interventions, and what must we do to adopt them? And if not, then what? Third, what are the sources of our sometimes conflicting evolutionary urges? On the one hand, we know that some people who suffer neurobiological deficits that conduce to crime do commit crimes, and sometimes they are heinous. For those crimes, however, at least some actors may not bear responsibility. On the other hand—and equally urgent—we have a necessary adaptive need to constrain them and sometimes to forgive them (although the latter is another lagging indicator). Last, what adjustments can we make to change the norms we use in our criminal law to reflect the new knowledge gained in the brain sciences and to effect positive changes in human behavior? Some of these questions are addressed here.

This Article intends to develop a theme of compassionate progressivism in the context of neuroscience and criminal law. This Article maintains that the brain sciences have added, and will continue to add, new and potentially useful sources of explanation for human behavior. Thus, the Article discusses the model of human behavior that our law now embraces, according to which virtually everyone possesses the capacity (gross and verifiable psychopathology excepted) to make


8. Under the Model Penal Code (MPC), all questions relevant to the defenses of insanity, duress, and others address issues of extraordinary individual vulnerability—cognitive failure, complete volitional failure, fear, and (at least historically) perceptions about the (mostly male) individual’s extraordinary vulnerability to certain settings—may be taken into account only under the standard of gross and verifiable. As to general questions of volition, however, the MPC drafters illogically and with some neurobiological naiveté, declared “an unwillingness to vary legal norms with the individual’s capacity to meet the standards they prescribe, absent a disability that is both gross and verifiable.” MODEL PENAL CODE § 2.09 cmt. 2 (“Stark, tangible factors that differentiate the actor from another, like his [or her] size, strength, age, or health, would be considered in making the exculpatory judgment.”).
responsible choices, nigh all the time. This conventional wisdom reflects a brilliant illustration of genotype and historical experiences that shape our intuitions and work together to constrain ourselves in the interest of long-term species survival; however, it is incomplete. As a liberal society committed generally to a progressive view of history, we must be prepared to make necessary adjustments in the interest of a more compassionate way of life. This Article traces findings from the brain sciences, constrained by the metrics of the various disciplines that fall under that umbrella, and findings applied to criminal law. These findings indicate that we have the potential for bringing more compassion to our substantive criminal law; thus, we are capable of producing a marginally safer society—one that yields to a fuller understanding of both who we are and what we are capable of achieving.

Toward those ends, this Article is divided into five sections. Section I presents a sketch of the prevailing dualist model of human behavior that still supports Anglo-American criminal law. The sketch situates the issues raised here within the jurisprudence of Anglo-American criminal law, and, in particular, our understanding of the roles of choice and character in punishment theory. I suggest that this focus on choice versus character reflects a false dichotomy; our decisions always reflect both, and neither is invulnerable to the vicissitudes of genetic expression.

With a benchmark established, Section II begins by setting out some of the major assumptions of the neuroscience, behavioral genetics, and evolutionary psychology that inform this Article. Section II then provides a brief synthesis of the selectional model of human behavior that is, in one form or another, broadly embraced by brain science researchers. A review of a fair sample of this exciting research generates the incontestable conclusion that each individual's unique environment (nurture) interacts with and thereby acts upon the individual's phenotype (nature) in an ongoing process that produces each unique individual. The environment, coupled with individual neurobiological differences, can bring about negative, unwelcome behaviors, but it also produces positive benefits for all individuals.

Next, Section III suggests both the limits and promises of current findings in neuroscience, a recurrent theme of this Symposium. Although neuroscience and the tools of brain imaging are sufficiently well developed to evidence our neurobiology in remarkable detail (roughly the size of a grain of rice or less), which was unimaginable until a decade or two ago, they are not yet adequately developed to be useful in the guilt phase of most criminal trials. Neuroimaging may and sometimes does serve to mitigate punishment in the sentencing phase of capital crimes, but in that setting the introduction of such evidence is
always double-edged. Imaging techniques are by their very nature, however, sufficiently well-developed today to effect some global substantive and procedural changes in our norms, including those related to burdens of proof, the definition of competency, and the availability of some defenses. Kathryn Kase and Emily C. Paavola will discuss this latter idea in the context of their hands-on, death-penalty work.

Finally, Section IV presents a normative case for beginning to overcome important primary barriers to achieving more compassionate ends in substantive criminal law, notwithstanding the damage some among us have suffered. Overcoming such barriers is largely a matter of bringing a major long-term commitment to a public policy in synchrony with a thickly described, publicly-shared commitment to a secular and more genuinely natural theology. Insofar as we reduce recidivism, we will be better off in the long run.

I. THE CARTESIAN MODEL AND CRIMINAL LAW

I have just convinced myself that nothing whatsoever existed in the world, that there was no sky, no earth, no minds, and no bodies; have I not thereby convinced myself that I did not exist? Not at all; without doubt I existed if I was convinced [or even if I thought anything]. . . . I am, I exist, is necessarily true every time that I pronounce it or conceive it in my mind.

A. Some Background

Most of us are familiar with at least part of Descartes’ quote. In his metaphysics, Descartes’ view of humankind rested in part on a kind of disembodied mind. Following the Platonic tradition, he dispatched the corporeal body to the periphery when it came to accounting for what makes a human life worthwhile: “And we also find so many other things in the mind itself which can contribute to the clarification of its nature,

9. Imaging is also used fairly routinely to illustrate brain damage in civil litigation. See O. Carter Snead, Neuroimaging and the “Complexity” of Capital Punishment, 82 N.Y.U. L. Rev. 1265, 1291-93 (2007) (surveying cases that have admitted imaging in civil litigation and discussing the double-edged nature of neuro-imaging in the death penalty context).
The Cartesian approach to self-knowledge has held some sway for well over three centuries. Nevertheless, at least since William James first published The Principles of Psychology in 1890, researchers have understood (or had access to information indicating) that the traditional Cartesian view of the mind, conceived as a lone navigator controlling mental functions, was premised on faulty biology. The Cartesian theory lent itself to the intuition, shared by adults and children alike, that within our skulls resides a central processing mechanism with the power to preview our relations with and thoughts about the world—our intentions—and then push the mental buttons (or, later, run a computer program) that produce the appropriate unified vision of the world and our response to it. Our intentions, merely kept alive by the body, direct all interactions between the individual and the world at large. Our bodies thus exist to house the mind and it is our bejeweled mind alone that controls our choices.

Locke rejected Descartes’s intuition-driven metaphysics in favor of an empiricism premised on observation and learning. Locke’s work nonetheless fed the Cartesian misunderstanding of the incorporeal mind through the familiar tradition of tabula rasa—the mind as a “blank slate.” This view holds that humans are born devoid of ideas; ideas and ideation come only with experience. Committed to Newtonian physics and its new way of sensing the world, and disdainful of the Cartesian notion of “innateness” (a view seen as inimical to the mathematical world introduced by Newton and his contemporaries), Locke rejected the idea of a special hands-on divine creation and moved to a converse view: ideas work through primary and secondary human qualities that then imprint themselves on human brains. As an approach to social

13. Id. at 32. Descartes’s approach was not, in fact, disembodied. He located the point of interaction between the body and mind in the pineal gland. See Gert-Jan Lokhorst, Descartes and the Pineal Gland, STAN. ENCYC. PHIL. (Spring 2009), http://plato.stanford.edu/entries/pineal-gland.


17. See HARRY PROSCH, THE GENESIS OF TWENTIETH CENTURY PHILOSOPHY 84-88 (1964) (explaining the Lockean distinction between those qualities that exist physically at the atomic level and those that exist as perceptions of such matters in human minds).
epistemology, Locke’s views served then contemporaneous, intellectual, and political philosophies that denied “any differences we see among races, ethnic groups, sexes, and individuals”; all such differences could be accounted for based on differences in experience.18

Locke was only half right. Unfortunately, the important insight—that individuals may possess different capacities that can be accounted for only biologically—was, at least in some instances, anathema and, for many historical reasons, remains so in contemporary culture.19 We are all viewed as capable of being conditioned by experience; thus, we are capable of controlling our destinies. This is not, however, entirely the case.20

The behaviorists of the first half of the twentieth century continued the trend toward a belief in universal “conditionability.”21 For the behaviorist, all mental activities are reducible to behaviors per se or to dispositions to certain behaviors. To display trait α is to engage in α or to be disposed to α-ing. Thus, to exhibit sadness, anger, or happiness is to engage in sad, angry, or happy behavior or possess an occurrent disposition to the same,22 which can be modified or conditioned by the use of appropriate behavioral techniques. Latter day behaviorists–functionalists–do not deny the existence of either mental operations or the mind.

Contemporary functionalists simply claim that the mind is indistinguishable from any other information processing machine. As John

19. One has only to recall the outrage engendered by suggestions that African-Americans and Caucasians may differ in athletic or intellectual ability based on some native qualities, or that women may not be as well suited to math and science as males. See, e.g., Marcella Bombardieri, Harvard Women’s Group Rips Summers, BOSTON GLOBE, Jan. 19, 2005, http://www.boston.com/news/education/higher/articles/2005/01/19/harvard_womens_group_rips_summers. These subjects are taboo. The response to RICHARD J. Herrnstein & CHARLES A. MURRAY, THE BELL CURVE: INTELLIGENCE AND CLASS STRUCTURE IN AMERICA IN LIFE (1994), is characteristic: Their suggestion that there might be inherent differences in intelligence was greeted not so much as bad science, which seems to be the case, but as racist. See, e.g., Oliver R. Goodenough, Biology, Behavior, and Criminal Law: Seeking a Responsible Approach to an Inevitable Interchange, 22 VT. L. REV. 263, 271-72, 278-79 (1997).
20. See, e.g., MODEL PENAL CODE § 2.01 cmt. 1, at 215 (Official Draft and Commentaries 1985) (defining “voluntary” in a way that refuses to “inject into the criminal law questions about determinism and free will”).
21. See PINKER, supra note 16, at 19. As John B. Watson declared, “Give me a dozen healthy infants . . . and my own specified world to bring them up in and I’ll guarantee to . . . train [them] to become any type of specialist I might select–doctor, lawyer, . . . and yes, even beggar-man.” Id.
Searle notes, mental states from this perspective actualize a certain kind of causal relationship; that is to say, a mental state is “any state of a physical system . . . that stands in the right causal relations to input stimuli, to other functional states of the system, and to output behavior.” Building on a behaviorist foundation, contemporary functionalists describe meaning as what in the end comes of a string of symbols that reflects various sensory inputs that are transformed into output according to a formal system, which operates without regard to content. On this telling, to be angry is to be in a state that is caused by a particular sort of stimulation to nerve endings (of one sort or another) that energize feelings of anger. Manipulate the symbols and you manipulate the person’s conduct. Life is reduced to algorithmic processes that produce certain predictable corresponding emotions.

The take-home point here is that the model of human behavior that drives much of contemporary criminal law and related public policy is still informed by a view of human behavior that denies significant differences in cognitive and volitional abilities based on human biology. Moreover, the standard distribution of capacities necessarily implies unequal capacities. As noted, in the legal domain everyone is deemed capable of making appropriate decisions in the absence of gross and verifiable psychopathology. Unarticulated in this view are assumptions about conditionability, character, and choice. All appearances to the contrary notwithstanding, killers like Jeffrey Dahmer, Andrea Yates, Robert Alton Harris, and the like are deemed competent and prima facie viewed as “sane” because they can effect a practical syllogism and “know” (at some points in time) that killing is wrong. Thus, they can move from a current desire to belief (about how to effectuate that desire) and then to an action that effects the desire. For that reason, we reach the legal conclusion that, but for their evil character, they could have chosen otherwise.

23. Id.
B. Choice and Character—A False Dualism

This section begins with a description of the Kantian substructure for a theory of choice in the law, then considers the choosing system described by H.L.A. Hart.\textsuperscript{28} Thereafter, it discusses character theory, a lineage that begins with Aristotle and runs through Hume and beyond, and posits that we choose our characters and, therefore, we choose to be criminals. Both positions highlight the fallacy of dualism; thus, they assume that a clear division exists when none does.\textsuperscript{29}

1. Choice as a Moral Imperative.\textsuperscript{30}

(a) Kant’s *Groundwork*. The role of rationality and autonomy in our moral deliberations, as with much else in moral theory, traces its modern origins to Kant.\textsuperscript{31} The commitment to rationality in contemporary normative ethics, and the nature of the reasoning it employs, begins, at least popularly, with the *GROUNDWORK OF THE METAPHYSIC OF MORALS*.\textsuperscript{32} Kant articulated his starting point by asking, “Do we not think it a matter of the utmost necessity to work out for once a pure moral philosophy completely cleansed of everything that can only be empirical and appropriate to anthropology?”\textsuperscript{33} That it was possible to construct a moral philosophy based upon “pure thinking,” altogether a priori and outside quotidian human psychology, was taken as an incontrovertible fact. Kant contended that “in matters of morality, [human behavior can] be easily brought to a high degree of accuracy and precision even in the most ordinary intelligence.”\textsuperscript{34} For present purposes, it is enough to appreciate that Kant’s commitment to

\textsuperscript{28} On the extent to which Hart’s views still pervade criminal law, see Sanford H. Kadish & Stephen J. Schullhofer, Criminal Law and Its Processes: Cases and Materials 536 (7th ed. 2001) (discussing the assumption of free will and rejection of determinism).


\textsuperscript{30} For a discussion of this material in greater detail, see Theodore Y. Blumoff, A Jurisprudence for Punishing Attempts Asymmetrically, 6 BUFF. CRIM. L. REV. 951, 963-71 (2003).

\textsuperscript{31} Certainly our commitment to the dominance of reason and rationality goes back to the Greeks and early Hebrews. See, e.g., Plato, *Crito, in GREAT DIALOGUES OF PLATO* 447, 450 (Eric H. Warmington & Philip G. Rouse eds., W.H.D. Rouse trans., Mentor 1984) (“My way is and always has been to obey no one and nothing, except the reasoning which seems to me best when I draw my conclusions.”).


\textsuperscript{33} Id. at 57.

\textsuperscript{34} Id. at 59.
rationality was wholly formal; thus, how individuals conduct themselves in fact is literally beside the point. The normative/descriptive division was complete.

Kant's formal commitment to a foundation for morality required that he assume the profoundly unempirical conclusion that luck could have no impact on the will:

A good will is not good because of what it effects or accomplishes—because of its fitness for attaining some proposed end: it is good through its willing alone—that is, good in itself. . . . Even if, by some special disfavour of destiny or by the niggardly endowment of stepmotherly nature, this will is entirely lacking in power to carry out its intentions; . . . even then it would still shine like a jewel for its own sake as something which has its full value in itself. Its usefulness or fruitlessness can neither add to, nor subtract from, this value.35

When the categorical goodness of will represents reason/autonomy's raison d'etre, and thus exists independent of the world, it produces a view of morality that is impervious to causative laws.36 The will literally exists apart from reality.37

GROUNDWORK is neurobiologically innocent: its message is simply that reaching good is within us. Its continuing vitality in the jurisprudence of our criminal law is, of course, subject to question. We know as a matter of common observation and behavioral genetics, for example, that events, conditions, and occurrences—in fact, all of one's experiences and many experiences over which actors have no control—impact everything we do every time we act.38 Hume understood this point when he noted that "[n]ature will always maintain her rights, and prevail in the end over any abstract reasoning whatsoever."39 Consider the ordinary incidents of birth to realize the point: our genetic make-up, our initial

35. Id. at 62.
37. I am not suggesting that Kant was unconcerned with practical ethics; he was. Even here, however, Kant was convinced that no one could be forced to do that which his will opposes. See, e.g., IMMANUEL KANT, LECTURES ON ETHICS 27-33 (Louis Infield trans., 1963).
38. Cacioppo et al., supra note 1, at 650.
39. DAVID HUME, ENQUIRIES CONCERNING HUMAN UNDERSTANDING AND CONCERNING THE PRINCIPLES OF MORALS 41 (L.A. Selby-Bigge & P.H. Nidditch eds., Oxford Univ. Press 3d ed. 1975) (1777). In what reads like a direct challenge to Kant, Hume disputes the distinction between reasoning and experience, arguing that the former gives form to the latter. Reasoning is the process of making sense of our experience and not the “result of our intellectual faculties, which, by considering à priori the nature of things, [somehow] examin[es] the effects[] that must follow from their operation.” Id. at 43-44 n.1.
socio-economic circumstances, our access to and use of prenatal and perinatal care, our introduction (or not) to moral and religious values, and substantial components of our personality—all are determined in whole or in part at the moment of conception and not long thereafter. These conditions are largely a matter of moral luck. We do not choose our biological parentage and all that comes therewith, nor do we choose the environments into which we are born. Moreover, we know that all of the events, conditions, and occurrences one faces throughout life can bring about lasting changes in one’s development. The impact of such phenomena on one’s penchant for crime seems too undeniable to disguise under any settled view. Our jurisprudence, however, seems to take this measure of a human into account only in the capital sentencing phase—after conviction of capital crimes—and even then its usefulness is always potentially undermined. Sometimes making the right choice is beyond the grasp of many damaged individuals.

(b) Hart’s “Choosing System.” Like Kant before him (but from a utilitarian’s perspective), Professor H.L.A. Hart generally assumed that virtually everyone has the capacity and opportunity to choose good. In his famous critique of determinism, Hart asked his readers to view the law as “a choosing system, in which individuals can find out, in general terms at least, the costs they have to pay if they act in certain ways.” The conception of choice implicates directly the compatibilist view of the will spawned by Kant. Hart’s analysis began by noting that individuals make choices routinely and predict future events as “a matter of empirical fact, and no form of ‘determinism’,[sic] of course, can show this to be false or illusory.” The determinist claim, according to

40. *See, e.g.*, Edelman, *Bright Air*, *supra* note 15, at 174 (noting that human organisms arrive more or less adapted to our environment in a process that occurs even when the environment springs surprises on us).


43. “Generally” is a necessary qualifier because Hart also understood that many individuals lack the capacity—whether in virtue of deficient intelligence or education—to make what the rest of society considers a “reasonable” decision. On the need to individualize justice in a way that accounts for non-pathological deficits, see H.L.A. Hart, *Punishment and Responsibility: Essays in the Philosophy of Law* 136-57 (1968).

44. *Id.* at 44. For an elaboration on this point, see Blumoff, *A Jurisprudence for Punishing, supra* note 30, at 967-71.


Hart, consists of two moves: First, determinism posits that human behavior is “subject to certain types of law” (although this has not been shown to be true). Second, if determinism could be shown to be the case, then the distinction the law draws between acting or not acting under excusing conditions evaporates as “unimportant, if not absurd.”

To rebut the determinist’s claim, Hart describes the planning and execution of a testamentary devise to illustrate his position. When a testator makes a will and the estate is administered posthumously thereunder, the testator has in a real sense “caused the outcome of the distribution made.” Hart acknowledges that the terms of the will issue from “a complex set of conditions, of which all the other members were as necessary for the production of the outcome as his choice.” He also notes that (1) the set of conditions that led to the choice is composed of conditions the full scope of which we may never know; thus, (2) the testator’s choice itself was the product “of some set of . . . sufficient conditions” of which we are ignorant. Even assuming (1) and (2) are correct, however, Hart insists (3) that these factors neither falsify the testator’s knowledge that he can make a choice to determine the distribution nor undermine the pleasure the testator receives from making the choices. If determinism cannot show statement (3) to be false or illusory, Hart concludes, “I for one do not understand how it could affect the wisdom, justice, rationality, or morality of the system we are considering.”

Hart’s view reflects a kind of binary theory of utility. He concedes that determinism exists as a “set of . . . sufficient [causal] conditions,” the full array of which we cannot explicate, but he argues for proceeding as if it did not. This view of determinism accepts that events have antecedent causes but holds that in an important, inexplicable

47. Id. at 29.
48. Id.
49. For an elaboration on this point, see Blumoff, A Jurisprudence for Punishing, supra note 30, at 967-71.
51. Id.
52. Id.
53. Id.
54. Id.
55. Compare Alan Norrie, Freewill, Determinism and Criminal Justice, 3 LEGAL STUD. 60, 62 (1983), and John L. Hill, Note, Freedom, Determinism, and the Externalization of Responsibility in the Law: A Philosophical Analysis, 76 GEO. L.J. 2045, 2056 (1988), with Michael S. Moore, Causation and the Excuses, 73 CAL. L. REV. 1091, 1092 (1985) (acknowledging the pressure of determinist forces but arguing “that moral responsibility for an action should be ascribed to an actor even when that action was caused by factors over which he had no control”).
manner agents control their own mental states, even though some (or all) of those states are themselves causally determined. 56 Although in a practical sense I will not challenge Hart's position, at least one question still has to be asked: Did Hart pose the right question? Others have argued that the important question Hart asks is not whether human behavior is subject to scientific laws, that much is conceded. Rather, Hart asks “whether . . . human behavior can be seen as caused by conditions external to the will of the actor,” 57 thereby placing the burden on the observer to demonstrate that the neurobiology of behavior is contrary to Hart's compatibilist perception. In contrast to this burden-shifting question, one can reply that not only can events be seen as caused by conditions external to the will, we know that events are affected by external causes, a view Hart concedes. 58 Thus, if it is admitted that under some description (for example, theoretical reasoning) there are exogenous conditions that determine an individual's conduct in some important way, then Hart's critique, like those of almost everyone else, can be viewed as suffering some question-begging.

Nor will it do to argue that choices exist because a gun pressed to the temple of a pedophile, for example, would prevent pedophilia; the pedophile would exercise choice and control. 59 That natural operates to put survival near the top of every being's motivational list is understood by everyone. The fear of death operates to inhibit conduct in any sensate creature if the conduct is in any way inhibitable. This conclusion is not merely based on the fact that individuals are guided by reason and, therefore, wrongdoers can forego unwelcomed conduct simply by using those processes to inhibit proposed or intended actions. From this perspective, virtually no misconduct short of the worst imaginable psychopathology deserves any exculpation. We acknowledge exculpation based on duress, for example, which is not pathological conduct. If a gun to the head were the baseline for determining volitional control, we should provide sufficient resources and exercise the will to inflict fear of death on the convicted pedophile. Perhaps we can also prevent bears or wolves from eating or reproducing. With sufficient force or threats we

56. Hill, supra note 55, at 2052 n.27. Hill also attributes to “soft determinist[s]” the notion that free action is absent only if an agent is caused to act against his will. Id. at 2052 n.28; accord Norrie, supra note 55, at 66 (describing freedom, in Hart’s scheme, as “the ability to follow one's desires no matter what their causes might be.”). 57. Norrie, supra note 55, at 61 (emphasis added). 58. HART, supra note 43, at 153-54 (likening the objective standard used in criminal negligence to absolute liability in cases when the defendant lacks capacity). 59. Stephen J. Morse, Addiction, Genetics, and Criminal Responsibility, 69 LAW & CONTEMP. PROBS. 165, 185 (2006); Stephen J. Morse, Crazy Reasons, 10 J. CONTEMP. LEGAL ISSUES 189, 213 (1999).
can prohibit virtually any conduct that we, as a society, have the will to prohibit (excretion, sleep, and death excepted).

The move from rationality to deterrence, however, works in many ways. It cannot be a sufficient factor that the person, unlike the bear or wolf, understands language and has some capacity for reason. That could mean that all species that understand communicated signals triggering fear reactions can be deterred, which assumes the very proposition at issue—that some capacity is both necessary for effective deterrence (fear of death) and sufficient without incurring the costs that such a policy entails. What is the sufficient capacity for effective, affordable deterrence to work is precisely the question at issue.

To be clear, no serious neuroscientist (or any other sober observer) advocates opening the prison doors and permitting violent crazy people to run free on the roads. Punishment is not procedural or mechanical in the way that the burden of proof is or that evidentiary standards of causation are, although these standards can be dispositive in many cases. Punishment is substantive. Very few occasions grab an individual's attention as quickly and tightly as does the emotional pain of incarceration (the bars being slammed closed behind him), and we need to cease viewing the legal universe as binary—guilty or not guilty, free will or determinism, yes or no. The universe is simply not categorical; the universe is at all times continuous. Dualist thinking tends to distort our view of the world. As Sapolsky points out, "scientists typically struggle to think in continua, a style that is a logical extension of thinking probabilistically." This is especially true in psychological disciplines "where, for example, there is a smooth genetic continuum between schizophrenia, a disorder of wildly disruptive delusional thinking, and schizotypalism, in which there are far milder ‘metamagical’ delusions." The capacities that make up our beings exist on a continua, including our personality types; these capacities do not exist in neatly confined boxes.

This is not to say that we can avoid all efforts at line-drawing because we cannot. It is to say, however, that where we draw those lines is our choice, and the choices we make are not written on stone tablets. The major point is that we have an obligation as humans to demonstrate our good character when we draw those lines so that everyone who is capable of rehabilitation should have a genuine opportunity to achieve that goal.

60. Sapolsky, supra note 2, at 1789.
61. Id.
2. Character and Law. In Nicomachean Ethics, Aristotle insists that each individual is responsible for his own character because his actions establish that character. Hume advanced a similar idea to account not only for the source of our actions, but also for our reactions to the conduct of others: “Actions are by their very nature temporary and perishing; and where they proceed not from some cause in the characters and disposition of the person, who perform’d them, they . . . can neither redound to his honour, if good, nor infamy, if evil.” Hume elaborated a dispositional (as opposed to a situational) viewpoint with an example of homicide.

Take any action allow’d to be vicious: Wilful murder, for instance. Examine it in all lights, and see if you can find that matter of fact, . . . which you call vice. In which-ever way you take it, you find only certain passions, motives, volitions and thoughts. There is no other matter of fact in the case. The vice entirely escapes you . . . till you turn your reflection into your own breast, and find a sentiment of disapprobation, which arises in you, towards this action. . . . It lies in yourself, not in the object.

On this view, we disapprove of vicious conduct not because it is vicious; rather, we identify it as vicious because we, in turning to our own dispositions (our “breast[s]”), disapprove of it. Morality, Hume tells us, resides in us, in our characters and dispositions. Such a determination would be relatively unimpeachable if all who are judged “bad” possessed control-in-fact over their characters.

One author follows the Aristotelian-Humean line and argues for a rule-utilitarian theory of excuses according to which moral demerit is

63. Id. at 1758 (maintaining that by virtue of their slackardly dispositions, men are “responsible for becoming men of that kind”). For a neurologically-informed critique of this view, see Carl Elliott, The Rules of Insanity: Moral Responsibility and the Mentally Ill Offender 29-31 (1996) (noting “that in many ways we are clearly not responsible for our characters, at least not as completely as Aristotle implies”).
65. For an elaboration on this basic social science distinction, see Theodore Y. Blumoff, The Problems with Blaming, in Law, Mind and Brain 127 (Michael Freeman & Oliver R. Goodenough eds., 2009).
68. For a discussion on rule-utilitarian thought, see John Rawls, Rule Utilitarianism, in Philosophical Perspectives on Punishment 82 (Gertrude Ezorsky ed., 1972) (distinguishing between justifications for the practice of punishment generally, and its
judged by the following dictum: “An agent is morally blameworthy . . . for an act if, and to the degree that, the moral code the currency of which in that society would maximize utility would condemn . . . him for it . . . .”

Condemnation is appropriate, therefore, whenever the actor lacks an internalized motivational set that produces (or should produce) appropriate feelings of guilt, shame, or dishonor in response to conduct that violates the moral code, absent a traditional assessment of excuse. Motivation is key; thus, an agent's conduct is excusable if, but only if, “an objectively wrong action (or an action in some way out of order) . . . does not manifest some defect of character.”

Brandt's description of character, which he distinguishes from a mere “trait of personality,” is terse: it is some internal quality that goes beyond a trait to include more or less permanent dispositions. For Brandt, the crucial moral question is whether “people would be trained to be motivated, and to feel, in certain ways about certain things—namely, to have an aversion to breaking a promise, to feel guilty about doing so,” that is, to act according to utility-maximizing rules of conduct. Implicit in this approach is the Aristotelian-Humean belief that the explanation for conduct reflecting character is internal to the actor and his desires, even if neither is fully within his control. On Brandt's view, “a defect of character is, or includes, a defect of motivation.” Presumably this

particular applications, and defending utilitarianism as an explanation for moral judgments thereunder), and John Rawls, Legal Obligation and the Duty of Fair Play, in LAW AND PHILOSOPHY: A SYMPOSIUM 3, 9-10 (Sidney Hook ed., 1964) (defining the duty of fair play as a scheme in which everyone benefits by mutual social cooperation and in which everyone or nearly everyone accepts certain restrictions on liberty to enjoy the benefit which is, in a sense, free, and stating conversely, a social arrangement is unstable insofar as any person knows that he can fail to cooperate but still enjoy the benefit).

69. Richard B. Brandt, A Utilitarian Theory of Excuses, 78 PHIL. REV. 337, 353 (1969). Although I believe the debate between character and choice theorists is, at best, substantially overinflated, see, e.g., R.A. Duff, Choice, Character, and Criminal Liability, 12 LAW & PHIL. 345 (1993), I assume that character is a relevant factor in the search for blame, especially when the issue of excusing misconduct arises. See, e.g., MODEL PENAL CODE § 2.04 cmt., at 275 (noting that the excuse of mistake of law applies when the “act charged is consistent with the entire law-abidingness of the actor”); MODEL PENAL CODE § 210.3, at 55 (stating that provocation acknowledges that “one who kills in response to certain provoking events should be regarded as demonstrating a significantly different character deficiency than one who kills in their absence”).

70. Brandt, supra note 69, at 354.

71. Id.

72. Id. at 355 (emphasis added).

73. Id. Brandt's survey of excusing conditions is fairly typical except insofar as he presses the motivational button: “All the considerations traditionally recognized as exculpating excuses are ones evidencing adequate motivation—or at least showing absence of evidence of inadequate motivation.” Id. at 357. Notably absent is serious consideration
means that the actor could have learned appropriate conduct but failed to do so because he lacked the appropriate motivational reinforcement. Whether any particular individual could be so trained, in the sense that he has adequate capacities for cognition and volitional control and has had the opportunity to learn the same, is the question raised here, but it is not an issue on which Brandt opines.74

Brandt’s view also reflects neurobiological innocence. No serious scholar in the field of brain sciences doubts that genetic endowment, for example, plays a substantial role in the construction of personality.75 Yet it is precisely these developments that our jurisprudence is only now beginning to take any cognizance of, and then generally only when the ultimate sanction of death is at stake.76 The basic problem raised by this view of character rests on the problematic assumption that all those wrongdoers whom the law deems sane and competent, for example, have both control over their character and that character in general is relatively stable over time.77 Although the latter point is contest-

74. Cf. Brandt, supra note 69, at 351-52 (stating that excuses entail societal costs insofar as the wrongdoer or potential wrongdoer believes that the clever lawyer will help him use the excuse to avoid incarceration).


76. For a discussion on this issue in the context of a deficiency in a specific brain enzyme, monoamine oxidase type A, which metabolizes certain neurotransmitters, see Blumoff, How (Some) Criminals Are Made, supra note 5.

77. Cf. ELKHONON GOLDBERG, THE EXECUTIVE BRAIN: FRONTAL LOBES AND THE CIVILIZED MIND 150 (2001). Goldberg suggests that data from neuroscience require “a new legal construct of ‘inability to guide one’s behavior despite the availability of requisite knowledge’ may be needed to capture the peculiar relationship between frontal lobe dysfunction and the potential for criminal behavior.” Id. Goldberg further describes a phenomenon characterized by the “nonpathological diminution of the ability to form a [common sense] theory of mind,” such as the inability to sense how others are reacting internally to us as reflecting normal variability in frontal lobe functioning. Id. at 108.
able, assume for now that individual moral development goes through stages and becomes more or less fixed in Kohlbergian terms at some point in time with respect to at least some areas of conduct. Even if this is correct, the point overlooks or dismisses as unimportant an incontrovertible fact: Who we are at $t$, the moment of wrongdoing on which we focus for rendering legal accounts, is a function of all the antecedent influences that impact on the decision made at $t$. All such influences play a formative role in decision-making although those roles are not fully discernible in the aggregate. Nor will it do to claim, as many do, that because determinism is universal and affects all of us the prospect of determinism can be dismissed. For now, suffice it to say that “universal” is decidedly not the same as “uniform.” We are each affected uniquely: some for better, some for worse. This brute social

78. See John M. Darley & Thomas R. Shultz, Moral Rules: Their Content and Acquisition, 41 ANN. REV. PSYCHOL. 525, 541-45 (1990) (discussing research on how children learn moral rules); Yoram Shachar, The Fortuitous Gap in Law and Morality, 6 CRIM. JUST. ETHICS 12, 24 (1987) (surveying Piaget's work among others and speculating “that human morality, once autonomously developed and formed, remains so for life in some areas of conduct, while other authorities replace parental authority in other areas and create in the human mind the same subservient nonautonomous opinion which is a mere reflection of external manifestations of attitude by such authorities”). As noted in DANIEL GOLEMAN, EMOTIONAL INTELLIGENCE (10th Anniv. ed. 2006), “the neurological data suggest [the existence of] a window of opportunity for shaping our children’s emotional habits.” Id. at xxii.


80. Bernard Williams makes this point about the instability of character judgments made at, or in reference to, a fixed point in time, in terms of the criteria needed to make such a determination:

[What one does and the sort of life one leads condition one's later desires and judgments. The standpoint of that retrospective judge who will be my later self will be the product of my earlier choices. So there is no set of preferences both fixed and relevant, relative to which the various fillings of my life-space can be compared. If the fillings are to be evaluated by reference to what I variously . . . want, the relevant preferences are not fixed, while if they are to be evaluated by what I now . . . want, this will give a fixed set of preferences, but one that is not necessarily relevant.


81. See, e.g., Sanford H. Kadish, Moral Excess in the Law, 32 McGeorge L. REV. 63, 75-76 (2000); Moore, Causation and the Excuses, supra note 52, at 1092 (arguing “that moral responsibility for an action should be ascribed to an actor even when that action was caused by factors over which he had no control”).

82. This is a basic fact of our genes and neurobiology. See, e.g., MATT RIdLEY, NATURE VIA NURTURE: GENES, EXPERIENCE, & WHAT MAKES US HUMAN (2003). See generally DAMASIO, DESCARTES' ERROR, supra note 15.
fact of existence challenges our conception of freedom because the conventional wisdom posits that “free action[s] should not be determined by antecedent conditions, and should be fully explained only intentionally, in terms of justifying reasons and purposes.”

Yet antecedent events and conditions obviously do matter greatly, and everyone—yes, everyone—knows it. Our well-nurtured intuitions shout out this basic understanding routinely. Even our ordinary, everyday usage underscores this fact. We routinely talk to our friends and neighbors across fences about our genetic make-ups, including our likenesses to Mom or Dad (“like father, like son,” “the acorn never falls far from the tree,” and so on), to our sisters or brothers, and the variations nature has carved out among our siblings. Findings from behavioral genetics and neuroscience have, for the most part, provided empirical support for our intuitions.

II. THE VIEW FROM GENETICS, NEUROSCIENCE, AND LAW

Darwin’s insight is simple, yet often misunderstood. It is this. . . . [If only some of a species] can survive, and if whatever helped them survive is passed to their offspring, then the offspring will be better adapted than their parents were. In this way the organisms become designed, by the blind processes of copying and selection, for the environment in which they live. As Dawkins puts it, if you have variation, selection and heredity, then you must have evolution.

Paul Bloom states that “[i]t is one of the oddest facts of nature that the unfeeling process of natural selection can construct creatures who themselves have feelings, who are sensitive to the pain of others, and who can work to make the pain go away.” Virtually everything else either informs Darwinian selection or follows therefrom.

Up to this point, this Article has discussed the settled jurisprudential understanding of individual moral psychology. Its predicate is formal and its model reflects the belief that, literally, almost everyone has the capacity and opportunity simply to choose good. Although it is an overstatement to conclude, as Professor Hart did, that the law is a...
“choosing system,” no one doubts that the law hopes to influence human behavior, and the criminal law expresses this hoped-for deterrence advertently. The basis on which the law and lawmakers make behavior-shaping preferences rests largely upon the theories of human nature just summarized. Those theories require adjustment from time to time. An assumption underlying this work is that, in general, the broader the source of reasonable epistemic deference, the better prepared we are to make public-policy decisions. Neuroscience, behavioral genetics, and the brain sciences generally ought to be among the sources that routinely inform our jurisprudence far more than they do now, which is mostly limited to death-penalty litigation and the proof (or lack thereof) of injury. This section offers several sketches that frame the basic currents in the brain sciences.

A. Among the Most Basic Assumptions

After many years studying how phenotypes are expressed (by examining the operation of our proximal sources of genetic inheritance), we now know that the chromosomes we receive from our parents and all the DNA therein are not composed simply of pre-impressed protein producing strings of nucleotides. Rather, our genetic inheritances are composed of the very stuff that generates open-ended selection–selection on-the-ground, so to speak. This remarkable process both permits and suffers us as individuals to adapt to our own unique environments. The function of much of our DNA exists ready to respond to the environment, whatever it brings. We are, in every way, the products of the fantastic number of synergies that merge nature and nurture, and nurture and nature, and so on and so on in endless interdependence. And we can effect some changes for the betterment of all. On what bases does this prediction rest? What follows is a list that includes many of the basic assumptions upon which a rich variety of empirical research, and many inferences therefrom, emerge.

86. See supra text accompanying note 44. See generally Jones & Goldsmith, supra note 4, at 459-60, 468-75 (noting that the demand for good will and its availability are inversely related, and that legal sanctions are often viewed as prices imposed on unwanted behaviors with the hope of reducing their incidence).

87. See, e.g., MODEL PENAL CODE § 1.01(2) (describing the purposes of the MPC’s provisions on sentencing and treatment); U.S. SENTENCING GUIDELINES MANUAL ch. 1, pt. A2 (2010) (setting out the basic statutory mission of the Sentencing Reform Act of 1984, 28 U.S.C. § 994(a) (2006)).

88. “Epistemic deference is the phenomenon in which one person uses the deliverances of some information source, perhaps the opinions of another person, as a model for what to believe.” James M. Joyce, Epistemic Deference: The Case of Chance, 107 PROC. ARISTOTELIAN SOC’Y 187, 187 (2007).
1. Human beings, like every species of every genus alive at any time in earth’s history, have evolved through the processes of heredity, variation, and natural selection. This process reflects millions of years of adaptation such that the basic architecture of our anatomy and physiology is itself millions of years in the making. Moreover, as creatures of heredity, variation, and natural selection, maintaining “fitness”—the ability to reproduce our phenotypic design—is a never-ending process. 99

2. Phenotypic expression in an unselected population—how our genes express themselves in a population living in its natural habitat—tends to be distributed in standard phenotypic fashion, mutations expected. 90

3. The brain (and the mind, if they are different) are also products of this enormously complex process; they too generally reflect functional adaptations—polymorphisms—to the environment in which they evolved. 91

4. The “psychological constituents of human . . . nature, like the anatomical and physiological elements thereof, exhibit adaptive design for the solution of particularly recurrent problems faced by our ancestors.” 92 Thus, decisions we make today are the product of neurobiological mechanisms that were initially developed in a primitive stage of human existence. 93


91. There are gaps between intention and neuronal firings that we may never eliminate as sources of inquiry. See, e.g., John R. Searle, RATIONALITY IN ACTION ch. 3 (2001). There is some evidence to conclude that the gap is filled, in part, by ion activity at the quantum level. Schwartz & Begley, supra note 42, at ch. 8.


93. Owen D. Jones refers to this phenomenon as “time-shifted rationality,” the idea being that our ability to process our cultural experiences occurs in brains that evolved under very different circumstances than we face today. Owen D. Jones, Time-Shifted Rationality and the Law of Law’s Leverage: Behavioral Economics Meets Behavioral Biology, 95 NW. U. L. REV. 1141 (2001) (arguing that what we perceive as irrationalities are often likely to be products of a temporal mismatch between the environment in which natural selection shaped the brain to function and different, modern environments that technology has only recently enabled us to study). I would add to Jones’s general description only that this shift in decision-making continues to occur within a selectional system that includes both the ongoing temporal and shifting effects of natural selection and
5. The basic morphology of our DNA includes architectural designs in our neuroanatomy (our cerebral cortex and subcortical mechanisms) and our neurophysiology (neurotransmitters, hormones and their regulators, and the like) that are themselves the phenotypic outcome of our genotype as they respond to the actual environments in which life occurs.94 It follows, then, “that two identical genotypes, placed in two different environments, may produce two quite different phenotypes with respect to any particular characteristic, behavioral or otherwise.”95

6. Notwithstanding the statements immediately above, it is also the case that many of the features that constitute human decision-making are inaccessible to us through introspection because “the phenomenology of deliberation and reasoned choice is often illusory and reconstructive.”96 The neurologist Michael Gazzaniga makes a basic point that our jurisprudence and moral philosophy would do well to understand and incorporate more fully:

Nowhere is the issue of [what constitutes] ourselves and our brain more apparent than when we see how ineffectual the mind is at trying to control the brain. In those terms, the conscious self is like a harried playground monitor, a hapless entity charged with the responsibility of keeping track of multitudinous brain impulses running in all directions at once.97

7. Evolutionary theory, among other resources within biology as a discipline, “can be useful in predicting, at least statistically,
both the environmental causes of [psychological brain] states and the nature of the responses that are likely to follow.\textsuperscript{98}

8. Our conception of nature and nurture, often serving as far more than a crude heuristic, is in need of substantial overhaul. In fact, it has never been the case that either genes or the environment drive human behavior. As Matt Ridley points out, “Genes are not puppet masters . . . . They are active during life; they switch each other on and off; they respond to the environment.”\textsuperscript{99}

B. Selection at Work: Open-endedness

These assumptions lead to the conclusion that evolution, including natural selection, heritability, and variation (along with genetic drift, and so forth), is an open-ended process that rests on a genomic structure that is at once both fixed—we all share roughly 99.9\% of the same genome\textsuperscript{100}—and fluid. Even the once prevailing wisdom that the adult brain is hard-wired and fixed, immune to change, is simply wrong.\textsuperscript{101} Neuroplasticity—the ability of neurons in the brain to generate new connections and rewire or remodel the brain—is never ending, although it is sometimes more limited in adults than in children.\textsuperscript{102} Our genome is fixed inasmuch as we humans share all but a tiny percentage of the same DNA (\approx .01\%), and it is fluid in that actual experiences are reflected in how any given individual adapts to his or her unique environment. The vehicle for these neuronal changes is genetic; they are preset to react to the environment, whatever it might be.

This section begins with a discussion of the composition of our genome and moves to the interdependence of “nature” and “nurture” in the making of an individual. The terms nature and nurture are placed in cautionary marks to suggest that although the dichotomy may yet provide some heuristic benefits, those benefits come at the cost of a basic misconception.

\textsuperscript{98} Jones & Goldsmith, supra note 4, at 423.
\textsuperscript{99} RIDLEY, NATURE VIA NURTURE, supra note 82, at 6.
\textsuperscript{100} See, e.g., Daniel L. Hartl & Elizabeth W. Jones, ESSENTIAL GENETICS: A GENOMICS PERSPECTIVE 244 (3d ed. 2002).
\textsuperscript{101} See, e.g., SCHWARTZ & BEGLEY, supra note 42 (detailing the history of the overthrow of the once conventional wisdom); ELKHONON GOLOB, THE WISDOM PARADOX: HOW YOUR MIND CAN GROW STRONGER AS YOUR BRAIN GROWS OLDER (2005).
1. Our Genetic Makeup. Geneticists have uncovered stores of fundamental data concerning the processes through which evolution by natural selection occurs. We have known for some time that genes provide the major vehicle through which natural selection operates. One of the discoveries is that only 3% or less of our DNA is pre-committed to phenotypic expression: the right number of fingers in roughly the right place with the expected shape, the point at which puberty begins, chins drop, hair grays, changes in the morphology of our brains occur, and so on. There is, however, far more to the DNA within us than that small percentage. It turns out that some of that 97%+ we have previously labeled “junk DNA” is not junk at all. At least some of the rubble has among its constituents the precursors that might enable us to move some of our distributed capacities in one direction or another, even as the most minute variations can produce death and destruction. It turns out that our genome operates with nature from both the inside and the outside to shape who we are.

(a) From the Inside-Out. If you asked any cattle breeder in the world if the sperm he purchases from different breeds of bull affects the aggressive tendencies in his female milk-producing off-spring, the


105. Of the roughly three billion chemical bases that compose a molecule of DNA, the most commonly cited figure indicates that the human genome is roughly 99.9% identical among all homo sapiens everywhere. See, e.g., Human Genetic Variation Fact Sheet, NATIONAL INSTITUTE OF GENERAL MEDICAL SCIENCES, http://www.nigms.nih.gov/Publications/Factsheet_GeneticVariation.htm (last updated Mar. 22, 2011). Thus, of those three billion base pairs (the familiar A-T and G-C) only a small percentage is actually code for proteins that provide something akin to a blueprint. The rest were, until recently, disparaged as “junk DNA.”

106. See, e.g., Researchers from Stanford University, Department of Biological Sciences Describe Findings in Genetics & Genomics, LIFE SCI. WKLY., Apr. 24, 2007, available at 2007 WLNR 7426550 (internal quotation marks omitted) (reporting that Stanford biologists have concluded that “the presence of junk DNA . . . might make an important contribution to the evolution of complex organisms”); Scientists Explore Function of ‘Junk DNA,’ SCI. DAILY (Nov. 21, 2006), http://www.sciencedaily.com/releases/2006/11/061113180029.htm.

107. This section is adapted from RIDLEY, NATURE VIA NURTURE, supra note 82.
breeder will identify you immediately as the neophyte your question reveals. Ask a corn grower or the cultivator of any farm commodity if the seeds she purchases for use in her soil affect plant productivity and you will receive the same answer: “Well of course they do. Any darn fool knows that much.” The milk we drink and the meat and produce we eat (and the insulin some among us use) are fabricated in part by genetically-managed mammals and genetically-managed seeds. The tendencies for aggressiveness and augmented yields have strong genetic modules.

These genetic tendencies will come as no surprise to ornithologists. They know, for example, that cuckoos migrating from North America to Africa and back, singing and mating with a member of their own species, do so despite the fact that they grow to adulthood without ever having met a parent or sibling.\textsuperscript{108} Certain traits and behaviors are either instinctive or have very powerful instinctive features. To that extent, some traits and behaviors do come from within.

In many ways, we humans are no different. Human twin studies make important, and not easily contradicted, points about the sources of human behavior. Consider the well replicated fact that monozygotic–identical–twins reared apart show a +.62 correlation on a survey of religious attitudes and a +.69 correlation on political attitudes. They do so under circumstances in which dizygotic–fraternal–twins reared apart correlate at .02 and 0, respectively, on the same self-assessment scales.\textsuperscript{109} Thomas Bouchard, who has spearheaded much of this research, makes a significant, counterintuitive point: even on features of human conduct that most of us would likely classify as purely cultural (or nurtured)–religious and political leanings, for example–there are

\textsuperscript{108} Id. at 52.
\textsuperscript{109} Id. at 79. It is clearly the case that studies using the tools of statistical analysis of variance can overstate the effect of any single trait on an individual; heritability measures population traits, not individual endowment. See, e.g., Elliott Sober, \textit{Separating Nature and Nurture}, in \textit{GENETICS AND CRIMINAL BEHAVIOR}, supra note 75, at 47 (commenting that twin studies using analysis of variance underestimate the assumptions they rest on). Nonetheless, the data provided in the text is impressive and worthwhile if analytically inconclusive.

Importantly, though, it is not my intention to assess claims about the extent to which genetic factors, in contrast with other factors, affect violent behavior. I do not advance a reductionist program of the sort which claims “that certain phenomena–say, violent human behavior–can be entirely explained by theories concerning apparently different phenomena.” See, e.g., Robert Wachbroit, \textit{Understanding the Genetics-of-Violence Controversy}, in \textit{GENETICS AND CRIMINAL BEHAVIOR}, supra note 75, at 25, 32-33 (critiquing ontological reductionism).
There is something in those variably long, alphabet strings of protein generators that tends to produce certain attitudes and behaviors over which we may have little (or no) control. The open issues of control include whether certain attitudes and behaviors arise, whether they are desired when they do arise, and whether once apparent and desired they can be contained. That said, our genes do not generally operate alone.

(b) From the Outside-in. All of our attitudes and behaviors are not fixed from within. If they were, we would have to conclude (among many other things) that we have wasted a lot of time and energy on nurturing and education of all types. Learning might be seriously circumscribed. We rightly refuse to believe that we are all helpless in the face of our genetic endowment. It turns out that some of our genes lie in wait to be turned on or off (and to turn on or off other genes) at some opportune time. This is the way selection operates in all living beings. Matt Ridley reports an important discovery about how creatures (including people) function. Whereas a small percentage of our genes guarantee that the overwhelming majority of individuals are born with all the right parts in the right places, they have other functions as well: “The function of many genes is . . . to help switch other genes on or off. And the susceptibility of a gene to be switched on or off depends on the sensitivity of its promoters,” a species of genetic material that facilitates the production of proteins when other genetic materials (“transcription factors”) attach themselves. What causes such genes to switch other genes on or off? Put simply, the answer is the environment, as defined broadly in terms of the unique, non-genetic experiences each individual encounters.

2. The Open-ended Process of Selection. Our legal system presupposes that each of us possesses a brain button that turns on and off behavior as if we were flipping a kitchen light switch. This presupposition is non-controversially understood by neurologists, cognitive psychologists, neuropsychologists, and others working within the brain sciences as inaccurate. Our cortical controls simply do not operate in a manner that resembles the Cartesian paradigm.

110. See generally Thomas Bouchard et al., Intrinsic and Extrinsic Religiousness: Genetic and Environmental Influences and Personality Correlates, 2 TWIN RES. 88 (1999).
111. RIDELEY, NATURE VIA NURTURE, supra note 82, at 32.
112. See supra Part I.A.
113. The MPC’s division of mens rea into four categories, which the drafters concede exist only on a continuum and cannot be rationally determinate without question-begging, constitutes implicit but only partial recognition of the way in which our control functions actually operate. See, e.g., MODEL PENAL CODE §2.02 cmts.
Although the world appears to us as a unified, bound picture, we now know that, while we do possess some variably localized centers for most of our perceptual processing, these perceptual processes are in fact dispersed among a mind-boggling number of neurons and neuronal groupings and connections. This intertwined city of neurons sometimes develops in parallel and redundant loop-like patterns, and sometimes they form along one-way paths as we experience our worlds—for good or bad—by selecting what is needed for adaptation, which works on the basis of “a preexisting capacity that an organism possesses from birth.”

What the process of selection entails in all creatures great and small is “the continual adaptive matching or fitting of elements in one physical domain [generally the frontal lobe of the cerebral cortex for humans] to novelty occurring in elements of another [the world around us].” Natural selection operates at the level of genomes—changing or mutating our genetic alphabet—and it does so on the basis of “recognition” rather than “information.” The receptive resources produced by natural selection stand ready to absorb information from the outside and respond automatically. We are designed to be that way, and these processes are always on duty, for better or worse.

One way to illustrate the distinction between recognition and other forms of information exchange is by reference to a familiar physical process, our immune system, which, like all of our systems, operates on the basis of selection by recognition. When an infection or disease or any form of invasive trauma occurs, a spectacular biochemical product of natural selection works over time on our genome; the system operates through decentralized resources that are recruited to attack the invaders. The system immediately identifies products in the body that are not us. The system’s magic lies in its ability to recognize immediately invading objects that are foreign. When “non-self” invaders appear, the system-wide biochemical process springs into action as lymphocytes recognize and bind to the molecular non-selves, targeting them for removal and destruction. The majesty and mystery of the process is that the encroaching outsiders do not pass information to the immune system about their novel qualities. Rather, our immune system recognizes the non-self pathogenic molecules without an obvious

114. Gazzaniga, supra note 97, at 14. There is, in fact, some dispute about the extent to which the environment may effect brain anatomy after birth.
information exchange from the invaders to the responders. In other words, the immune system exists within us and arrives at problems ready to recognize and react against foreign invaders.\textsuperscript{117} This system of selection is \textit{open-ended} and pervasive; it operates within every sphere of our lives.

Despite our persistent primitive intuitions, within this selection system there is no single neurobiological control center.\textsuperscript{118} It does not work that way. Rather, our capacities are dispersed in a process of diffusion that often distributes normally among millions of neuronal groups that deliver the world to, and process it for, us. These groups generate specific capacities that generally vary along familiar standard distributions.\textsuperscript{119} This occurs because, like our immune system, to survive we must continually select and develop \textit{based on our actual experiences} so that on any day in question our cognition, our perceptions, and the processes we bring to our choices necessarily vary.\textsuperscript{120} To choose anything or nothing is to make a choice in this system. Two important points follow from this biological fact: First, our hard-wiring (genotype) was formed at a time when simply surviving and passing on one's genes to progeny were all that life required and probably as much as anyone could perform. Second, and at the level of phenotype, each individual makes the choices he then \textit{can} effect, which depend in large part on the actual circumstances and experiences he encounters.

The take-home point here is so closely aligned with our intuitions that it should not need emphasis: The \textit{actual circumstances} of our lives affect

\textsuperscript{117} EDELMAN, BRIGHT AIR, supra note 15, at 75-79 (noting that the immune system is a "recognizing system [that] first generates a diverse population of antibody molecules and then selects \textit{ex post facto} those that fit or match. It does this continually and, for the most part, adaptively."). Edelman won the 1972 Nobel Prize in medicine for this discovery. The Nobel Prize in Physiology or Medicine 1972, NOBEL PRIZE, http://nobelprize.org/nobel_prizes/medicine/laureates/1972 (last visited Apr. 3, 2011).

\textsuperscript{118} As one researcher points out, even within a single system, such as the visual system, dimensions like color, motion, location, and object identification are processed in different areas of the brain. Adina L. Roskies, The Binding Problem, 24 Neuron 7, 7 (1999).

\textsuperscript{119} See ANTONIO DAMASIO, THE FEELING OF WHAT HAPPENS: BODY AND EMOTION IN THE MAKING OF CONSCIOUSNESS 99 (1999); EDELMAN, BRIGHT AIR, supra note 15, at 28-29; SEARLE, MIND, LANGUAGE AND SOCIETY, supra note 22, at 90; Andrew E. Lelling, Comment, Eliminative Materialism, Neuroscience and the Criminal Law, 141 U. Pa. L. Rev. 1471, 1495 (1993). This is not to say that there is not also domain specificity; there is. It is to say that along with specificity there is dispersal so that systems operate together to bring about perception. See, e.g., Semir Zeki, The Visual Image in Mind and Brain, in THE SCIENTIFIC AMERICAN BOOK OF THE BRAIN 17, 17-28 (1999).

\textsuperscript{120} JOSPEH LEDOUX, SYNAPTIC SELF: HOW OUR BRAINS BECOME WHO WE ARE 74-79 (2002).
both our morphology and individual development; these are indefeasible facts of human existence. Comparing our brains to our immune system “shows that genetic evolution does not invariably lead to the kind of modularity that excludes open-ended processes. Instead, it can create processes that are themselves evolutionary and therefore capable of providing new solutions to new problems.”

Antonio Damasio states the crucial point:

[A]s we develop from infancy to adulthood, the design of brain circuitries that represent our evolving body and its interaction with the world seems to depend on the activities in which the organism engages, and on the action of innate bioregulatory circuitries, as the latter react to such activities.

3. The Way It Works: The Macro Level. To this point, we have examined the jurisprudential model of human behavior, which assumes that individuals at virtually all times have the capacity to throw the “right” switch and effect the “right” decision. Descartes’s mind-body dualism still holds sway in much of our jurisprudence and its processes. We next looked at the operation of natural selection, which demonstrates that evolution has created a genomic structure that is open and ready to respond to the world. This next part briefly reviews the product of and the mechanisms that deliver the magic of recognition and adaptation.

It is true that the neurons in our brains operate mechanistically. Once an action potential is reached, the cell will fire, as is explained below. That does not mean we are simple automatons, however. (There may be enough play in the quantum nature of individual nerve cells to account for the ability of most people, most of the time, to will actions.)

This next subsection looks briefly at the operation of the nervous system, which permits us to interact with the world and learn

122. DAMASIO, DESCARTES’ ERROR, supra note 15, at 111.
from our experience, and examines the mechanisms for selection in the monoamine oxidase (MAOA) case.

Our skulls are filled with billions of neurons that wait at rest (in “resting potential”) to be aroused, initially, by some signal(s) from the environment. When alerted, a dendritic branch—the part of a nerve cell that receives signals and initiates the brain’s internal information flow—now sufficiently aroused—sets off a chemical reaction (an “action potential”). This reaction excites the resting neuron at its axon, a long projection covered in myelin that, so excited, carries an electrical charge to the neuron’s “axon terminal,” where connections are made to the next neuron or neuronal group(s). Once a neuron is triggered at the “axon hillock” the process of electrical transmission moves forward undiminished in strength until information is passed along to the next neuronal connection at the axon terminal or post-synaptic terminal.

A Typical Neuron

How neurons communicate with each other is also a vital part of this story. For all the billions of neurons in our heads, there is a tiny microscopic gap—a synapse—between each, and this gap must be traversed chemically for information to be transmitted from one neuron to the next. A variety of neurotransmitters accomplishes this feat of synaptic transmission, “the basic building block of virtually all brain

125. This image is available at http://www.mindcreators.com/NeuronBasics.htm. This image has been reprinted with permission.
These neurotransmitters—chemicals packaged in vesicles that either excite or inhibit the next neuron in the line—should fit neatly into the corresponding receptors in the next neuron. If the transmitters do not fit properly, there is likely to be a problem, sometimes a serious behavioral problem; we return to this topic in the next section.

The Brain

126. GREENFIELD, supra note 123, at 7.

127. E.g., id. at ch. 4 (discussing the impact of drug use on neurotransmission); ROBERT M. SAPOLSKY, WHY ZEBRAS DON’T GET ULCERS 278-84 (3d ed. 2004) (describing the neurochemistry of depression).

128. The image above was produced by Stephanie Seneff and has been reprinted here with permission. For more information, contact seneff@csail.mit.edu.
These often microscopic neurons operate within the gross anatomy of the brain. The brain is organized into at least three major systems. One, the thalamocortical system, lies deep within the brain and is connected to the cerebral cortex (or laminae, the multi-layered gray matter that envelopes most of our brain anatomy) through bi-directional input and output mechanisms. Thus, most of the neurons in this system are connected reciprocally in that they signal in both directions (back-and-forth) so that stimulus input is grasped, organized, and categorized. In a healthy individual, these mechanisms commonly generate excitation down thousands of connected neurons.

Among the critical performance centers within this system is the prefrontal cortex (PFC) and the amygdala. The PFC houses our executive functions. The PFC is also connected to centers of motor control; more importantly, the PFC is linked with the oldest part of our brain, the brain stem, which houses our “fight or flight” response to fear. Properly functioning, the PFC acts to suppress the more atavistic tendencies of the brain stem. The brain stem is the most fundamental component of the brain, one that “deviates relatively little in a vast range of species, from reptiles to humans.”

The PFC is thus implicated in behavior. In particular, the PFC “sends large inhibitory projections into the limbic system, particularly the amygdala, a region heavily implicated in aggressive behaviour.” A core function of PFC activation is anticipation of reward via interactions between the neurotransmitter dopamine and the PFC. These interactions can change in strength and can “take the form of an enhanced capacity to sustain dopamine release as the interval between the onset of a task and its reward increases. This would constitute the neural basis of an increasing capacity for self-discipline and gratification postponement.” For example, the leading hypothesis today among neuroscientists who study abnormal behavior “is that in psychopathic criminals the [PFC]-amygdala connections are disrupted, leading to

130. For a summary of this point, see Oliver Sacks, Inside the Executive Brain, N.Y. REV. BOOKS, Apr. 26, 2001, at 46 (reviewing ELKRONON GOLDBERG, THE EXECUTIVE BRAIN: FRONTAL LOBES AND THE CIVILIZED MIND (2001), which noted that the frontal lobes are the most recently evolved--and last to be celebrated as the most important--region of the human brain).
131. GREENFIELD, supra note 123, at 3.
132. Sapolsky, supra note 2, at 1791.
133. Id. at 1792.
deficits in contextual fear conditioning, regret, guilt, and affect regulation.”

The second major neuroanatomical assembly operates unidirectionally; the neurons transmit “information” or signals along axons—the neuron’s length—in only one direction. This assembly is composed of three structures: the cerebellum (mostly concerned with coordination and motor synchrony—capacities about which we do not want consistent feedback), the basal ganglia (largely responsible for planning and executing complex motor movements), and the hippocampus, which plays a crucial role in short and long-term memory functions and how they are stored (a system over which we wish we had some control).

The third major system consists of a diffuse set of connections concentrated in the brainstem and hypothalamus. A key structure in directing the relationships among the many systems is the amygdala, a major player which, not surprisingly, participates in our emotional life and is constituted by a set of neurons that lie at the “neuronal crossroads, perfectly positioned for the meeting of previously unassociated inputs converging from different brain regions.” As noted, the amygdala, along with the PFC, also plays a prominent role in our responses to fear-inducing situations. Among other things, the hypothalamic/brain stem region releases hormones (blood-born neurotransmitters) and other neuromodulators, chemicals that influence neural activity, including value systems, and ultimately human behavior.

“Value systems” are essential to our brain’s efforts to maintain reasonable homeostasis. They are in some ways the key to natural selection. These systems include the “phenotypic aspects of an organism that were selected during evolution and constrain somatic selective events, such as the synaptic changes that occur during brain development and experience.” A value system is thus composed of those observable characteristics of our species that, in operation, define and constrain our developmental functioning. For example, think about the shape of our hands and our prehensile thumb, or the nature of our perceptual apparatuses, among many others: respectively, they provide

135. See, e.g., GREENFIELD, supra note 123, at 19, 67.
136. Id. at 20.
137. See generally JOSEPH LEDOUX, THE EMOTIONAL BRAIN: THE MYSTERIOUS UNDERPINNINGS OF EMOTIONAL LIFE (1996); Sapolsky, supra note 2, at 1791.
138. See, e.g., EDELMAN & TONONI, supra note 129, at 42-47.
139. Id. at 88.
a framework for tactile and visual possibilities. In a word, value systems make possible our ability to orchestrate our “perceptual [and] behavioral response[s].”¹⁴⁰ Such systems are necessary preconditions to organizing our universes, but they are not sufficient alone to permit understanding.¹⁴¹ Learning and adaptation occurs when perceptual categories and memory are linked to hedonic centers, which attach value to the categories. These centers include the usual: sexual, other appetitive functions, and our maintenance systems generally.¹⁴²

Learning, for good or ill, seems to occur when global maps and value centers within the brain are linked neurally.¹⁴³ Learning “connect[s] categorization to behaviors having adaptive value under conditions of expectancy,” when expectancy refers to places (“set points”) within those neurobiological structures that make up parts of our hedonic systems that are not yet satisfied.¹⁴⁴ “Learning is achieved when behavior leads to synaptic changes in global mappings that satisfy the set points.”¹⁴⁵ Memory, whether explicit or implicit, involves being able to repeat a performance, and it is key to learning.¹⁴⁶ Moreover, memory is a system property that occupies different populations of neuronal groups within the brain. Unlike computers, we do not store bits of coded information awaiting the appropriate input to be spat out on command. Rather, memory operates dynamically to enhance an ability to categorize events in different locations within the brain.¹⁴⁷

¹⁴⁰.  †Id.†
¹⁴¹.  †Id.†
¹⁴².  EDELMAN, BRIGHT AIR, supra note 15, at 100.
¹⁴³.  “Mapping” is the process whereby information from receptors on the body (touch or vision) finds a point on the cortical sheets that compose the brain. These maps permit the brain to respond to a three-dimensional world “with spatial signals about pressure or wavelength differences” in the four-dimensional world we live in (where time is the fourth dimension). †Id. at 19.†
¹⁴⁴.  †Id. at 101.†
¹⁴⁵.  †Id.†
¹⁴⁶.  Explicit or “declarative” memory is the stuff of concentration, that is, it occurs when “we are aware we are remembering something in the first place.” GREENFIELD, supra note 123, at 67. Central here is the hippocampus. Implicit or “procedural” memory describes the effortless execution of tasks that comes from repeated practice, whereby learned sequences are organized into an “autopilot” effect. †Id. at 66-67; accord Cacioppo et al., supra note 1, at 654; Sapolsky, supra note 2, at 1790.†
¹⁴⁷.  If you doubt this, simply recall the last time you were unable to remember a specific event, name, or label. Suppose it is a place you have visited. You can picture the place in your mind; perhaps you can remember the people you were with at the place; you might remember where you had lunch that day and some of the other things you did, maybe what you wore, why you were there, and so on. Note what we do in these circumstances: we rummage around our brains recalling a great deal about the scene and, from everything we know about memory, we are recruiting and culling data that is stored
This occurs by continual “recategorization,” that is, repeated rehearsals of similar information in different contexts. As Edelman and Tononi point out, “There is no prior set of determinant codes governing the categories of memory, only the previous population structure of the network, the state of the value systems, and the physical acts carried out at a given moment.”

Put otherwise, there are no memory algorithms. Memories arise because “of accumulations of synaptic changes in the cortex as a result of multiple reinstatements of the memory,” but synaptic changes alone are not sufficient either. Rather, memory is a process that requires the use of a number of circuits that produce a similar result. For that reason, memory “does not replicate an original experience.”

The importance of this fact is that our brains—and the “minds” that our brains constitute—can be changed, literally and (to some extent) at all times. Ordinary aging aside, our brains and minds can and do change in several different ways. One is through learning, a process dependent upon the environment in which one lives and the conditions to which one must adapt, again, for good or for ill. Closely related are environmental effects on our ability to control the process of neurotransmission, which can be implicated in crime.

4. The Way It Works: The Micro Level. That the environment affects human behavior, a point wholly consistent with our common observations, is a well-established neuropsychological verity. A pertinent example of this phenomenon was teased out of a multitude of data by a team of neuroscientists led by Avshalom Caspi and Terri Moffitt. Caspi and Moffitt tested “the hypothesis that childhood maltreatment predisposes most strongly to adult violence among children whose [monoamine oxidase] is insufficient to constrain maltreatment-induced changes to neurotransmitter systems.” Monoamine oxidase (MAOA),

in different places. Memory is the act of pulling those pieces together to access a single name. People with Alzheimers, for example, have a harder time pulling those bits of information out of their brains than the rest of us because some of their brain functions have degenerated. See SAPIER, WHY ZEBRAS, supra note 127, at 208-10.  

148. EDELMAN & TONONI, supra note 129, at 98.  

149. LEDOUX, SYNAPTIC SELF, supra note 120, at 107.  


refers to brain enzymes that come in one of two forms, A or B. They are responsible, with other neurochemicals, for the necessary degradation of neurotransmitters after neurons have fired, thereby stopping the previous signal to permit a new signal to get through to the next neuron.  

Synaptic Transmission

behaviors defined as a continuous trait . . . via the DSM diagnosis of ASPD”); Cathy S. Widom & Linda M. Brzustowicz, MAOA and the “Cycle of Violence:” Child Abuse and Neglect, MAOA Genotype, and Risk for Violent and Antisocial Behavior, 60 BIOLOGICAL PSYCHIATRY 684 (2006) (finding that high level of MAOA serve to buffer white males who are exposed to abuse and neglect during childhood from the cycle of violence such as later antisocial and aggressive behavior). The particular phenomenon may, however, be limited to white males. Richard L. Sjöberg et al., Adolescent Girls and Criminal Activity: Role of MAOA-LPR Genotype and Psychosocial Factors, 144 AM. J. MED. GENET. PART B: NEUROPSYCHIATRIC GENETICS 159 (2007); Widom & Brzustowicz, supra, at 688.  

152. See Sjöberg, A Non-additive Interaction, supra note 151, at 429 (“The MAOA enzyme metabolizes dopamine and other monoamine neurotransmitters such as serotonin that are critical in emotional responses and behavioral inhibition.”). For a definition of MAOA, see http://www.answers.com/topic/monoamine-oxidase.  

153. The image is from http://click4biology.info/c4b/6/hum6.5.htm. The image has been reprinted with permission.
Studying more than a thousand white children, over half of whom were boys at various cohorts and longitudinality, the Caspi-Moffitt team discovered that boys who suffered deficits in a key neurochemical and who grew up in an abusive environment were substantially more likely to engage in violent, anti-social behavior that led to unwelcome interactions with the criminal justice system than were boys raised either with the deficit but in a reasonably healthy environment or who were raised in a healthy environment without the MAOA deficit. The data demonstrated that children raised in abusive environments differ significantly in the likelihood that they will engage in violent behavior, “depending upon whether or not their genotype conferred high or low levels of MAOA expression.”154 Interestingly, the deficit in type A monoamine-oxidase does not alone conduce to later violence; it is the combination of a neurochemical anomaly plus abuse in the young child's environment that produces unwanted developmental patterns.155

In subsequent work, the original researchers confirmed their earlier findings, expanded upon them, and advanced the basic notion that it is the environment that tends to produce the (mal)adaptation in light of individual differences and not a genetic deficit alone that causes the poor behavior. This is consistent with, and is in fact an example of, the primary realization that selection is an open-ended phenomenon:

Heterogeneity of response characterizes all known environmental risk factors for psychopathology, including even the most overwhelming of traumas. Such response heterogeneity is associated with pre-existing individual differences in temperament, personality, cognition and autonomic physiology, all of which are known to be under genetic influence. The hypothesis of genetic moderation implies that differences between individuals, originating in the DNA sequence, bring about differences between individuals in their resilience or vulnerability to the environmental causes of many pathological conditions of the mind and body.157

155. See Christopher J. Ferguson, Genetic Contributions to Antisocial Personality and Behavior: A Meta-Analytic Review from an Evolutionary Perspective, 150 J. SOC. PSYCHOL. 160, 162 (2010), available at http://www.tamiu.edu/~CFERGUSON/evmeta.pdf (noting that single gene polymorphism does not, alone, conduce to antisocial personality and behavior, but rather, the genes interact with each other and combine environmental risk factors—such as family violence—to produce unwelcome aggressive behavior).
156. See supra note 151.
Although much research is yet to be done before these interactions are fully understood and some kind of fix may come along, Caspi and Moffitt's research clearly indicates that “the gene-environment interaction approach assumes [and strongly suggests] that environmental pathogens cause disorder.”

The more general take-home point here is made by Allan Gibbard: “The genetic plan for a human being will be full of contingency plans: full of schemes that in effect say ‘If A then do X, whereas if B then do Y.’”

Given a difference in how two people act, it is perfectly biological to say something like this: the two people's genetic plans [their genotypes] are the same in relevant respects. They’ve encountered, though, different cues as to their circumstances. The cues the two have encountered differ in ways for which the single genetic plan they share makes provision. The plan they share is to respond one way given the one set of cues and another way given the other. The cues in question may be immediate ones, or they may be cues that came years ago in childhood and have affected the development of psychic mechanisms or the setting of parameters for them.

There is rich data in the neuroscience literature indicating that early maternal rejection, physical or psychological abuse, and exposure to environmental toxins conduce to violent behavior as the child matures.

Raise a child in an abusive environment and the child, through no fault of his or her own, is likely to suffer an important neurobiological deficit or insult, and the likelihood is understandably increased that the child will become a violent adult. We have known all along, however, that such assaults affect development negatively, just as we have known that the absence of touch and warmth in the early stages of development conduces to more violence. Child abuse affects the

158. *Id.* at 583.
160. *Id.* at 174.
163. Tiffany Field, *Violence and Touch Deprivation in Adolescents*, 37 ADOLESCENCE 735 (2002); see also Jennifer E. Lansford et al., *A 12-Year Prospective Study of the Long-Term Effects of Early Child Physical Maltreatment on Psychological, Behavioral, and Academic...
concentrations of certain cerebrospinal fluids, and exposure to environmental toxins of all sorts can produce deviant behavior. Nevertheless, we generally refuse to adjust our legal environment to these facts.

III. THE IMPLICATIONS FOR CRIMINAL LAW OF NEUROSCIENTIFIC DATA

People who commit crimes and endanger the well-being of others must be treated, confined, or both. No responsible observer believes otherwise. The neuroscientist Robert Sapolsky, who documents the fact that some individuals with PFC deficits know the difference between right and wrong but are nonetheless “organically incapable of appropriately regulating their behaviour,” understands the illogic of blaming those who suffer neurobiological deficits. He also recognizes that this view “does not eliminate the need for forceful intervention in the face of violence or antisocial behaviour.” Laurence R. Tancredi and Jonathan D. Brodie note that fMRI data may be very useful in setting group norms in the context of brain research, but the data is not yet useful for exonerating individuals in the courtroom. Joshua Greene and Jonathan Cohen, self-described hard determinists, suggest that, in time, we may need to jettison entirely our traditional understanding of free will, but they also state that the law will always have practical reasons for punishing some individuals. They do predict, however, that in the future “the idea of distinguishing the truly, deeply guilty from those who

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166. Sapolsky, *supra* note 2, at 1787.

167. *Id.* at 1794.

are merely victims of neuronal circumstances will... seem pointless."

The data from the brain sciences favoring some changes in our jurisprudence is compelling: Our environments can trigger phenotypic change and neuronal growth or death in a process of constant self-origination. As noted above, there was for generations neuroscientific orthodoxy declaring that adult animals of almost every sort lacked the capacity to generate new cortical neurons. That position has given way to increasingly sophisticated research showing that all primates, including human beings, have the capacity for generating new neurons well after childhood development has ended. It is now clear from research on subjects as apparently dissimilar as brainless worms and baby mice to human beings that all God's creatures are capable of learning. Such learning is accompanied by changes in the neurobiology of all animals.

These conclusions butt hard into our commitment to the easy formalism that pulls us in the direction of the comfortably familiar dualism of the past and all that its collective wisdom generally entails. What is less clear is why our law is generally unwilling to concede the fact that individuals vary in their cognitive and volitional capacities for control based on impoverished G × E (genes and environment) interactions, and that how we treat these individuals, given documentable deficiencies, should vary from person to person. One universal characteristic among all creatures is that the laws of nature constrain what is possible for any given individual at any point in time. Criminality, and especially those forms of crime that are reflected in angry, emotionally-charged, and unintelligible misconduct, is in substantial measure a product of adaptation under circumstances over which the actor often has, at least initially and crucially, no control. As a result, not all actors have the capacity-in-fact to restrain either the occurrent desire to act out their angry feelings or the rise of those feelings in the first place. This is not to deny that such angry actors lack the capacity for intentional conduct; they too possess frontal lobes and a capacity for executive functioning. It does deny that every non-psychopathologi-

169. Greene & Cohen, supra note 7, at 1781.
170. RIDLEY, NATURE VIA NURTURE, supra note 82, at 145-46.
171. Id. at 146-49.
172. See generally GOLDBERG, THE WISDOM PARADOX, supra note 101. There is data supporting the notion that psychopaths, in particular, have well-functioning logical processes; they simply cannot help themselves absent a gun to the head. See, e.g., Peter Johansson & Margaret Kerr, Psychopathy and Intelligence: A Second Look, 19 J. PERSONALITY DISORDERS 357 (2005) (finding no difference in general intelligence between psychopaths and nonpsychopaths); Mobbs et al., supra note 134, at 694-95 (footnotes
cal actor who commits harmful acts in fact possesses adequate capacity to meet the social norms of control. The ability to control also exists on a continuum, and those individuals on the left tail of that continuum may possess inadequate mechanisms for control yet not meet the extant standards for insanity or lack of competency. Such wrongdoers usually require incapacitation and always require rehabilitation, but they do not necessarily deserve punishment and blame in the hell-holes that constitute our prison system.

Our folk psychology is generally a wonderful resource for the successful use of practical reasoning. We could not exist without it. Folk psychology tells us when to be cautious even before we fully perceive a threat; it ordinarily permits us to make wise decisions about the people with whom we must and choose to associate; it usually permits us to decide how to allocate our time and prioritize events; and so on. There are strong emotional modules at work that inform our ability to engage in practical reasoning. Despite our undoubted commitment to seeking a more comprehensive understanding of the human condition, we sometimes permit predispositions to withhold the approval of new learning because some truths are hard to accept; they often appear threatening. For that reason, we are usually right to be skeptical of challenges to our received folk psychological wisdom—skeptical both theoretically and epistemologically, when the former calls into question the implications of major changes for social order and the latter calls into question on various grounds the soundness or bases of some new scheme of beliefs or system of thought. When the data

omitted) (noting that a central thesis “is that in psychopathic criminals the prefrontal-amygdala connections are disrupted, leading to deficits in contextual fear conditioning, regret, guilt, and affect regulation”).

173. See, e.g., Sapolsky, supra note 2, at 1787 (arguing that PFC damage can produce individuals who know the difference between right and wrong and are, nonetheless, “organically incapable of appropriately regulating their behaviour”).

174. Here, I am using the phrase “folk psychology” to describe a theory of human psychology which is represented in the mind-brain and which underpins our everyday capacity to predict and explain the behavior of ourselves and others. On this view, folk psychology is a data structure or knowledge representation which mediates between our observations of behavior-in-circumstances and our predictions and explanations of that behavior. Ian Raverscroft, Folk Psychology as a Theory, STAN. ENCYC. PHIL. (Winter 2005), http://plato.stanford.edu/archives/win2005/entries/folkpsych-theory (emphasis omitted).

175. See, e.g., DAMASIO, DESCARTES' ERROR, supra note 15, at 166-76 (discussing the somatic marker thesis).

demand a change, however, they should be heeded: “Social policy must adapt to a world in which everybody is different.”

What follows is an outline of the potential for neuroscience in criminal law, beginning with what it cannot now do, at least at this point in time, and then moving on to what it can do. The techniques of cognitive neuroscience and brain imaging cannot tell any fact-finder what was going on in the mind of the defendant at the time he committed a crime. Nor can we yet determine whether an individual—a witness, for example—is telling the truth, overstated claims to the contrary notwithstanding. These techniques, however, certainly can tell when our norms should be adjusted to account for the background of the individuals whose conduct we rightly sanction.

A. What Neuroscience and Behavioral Genetics Cannot Now Do and What It Can Do

A somewhat surprising and refreshing consensus is emerging in the neurosciences. The agreement is reflected in this Symposium in its participants appropriately modest outlook on neuroscience’s current impact concerning what this emerging field tells us about the less observable, neurobiological facets of an individual life. Most seem to agree with the late Richard Feynman’s understanding of success in science, which emphasizes how long and hard one needs to work to gain even a tiny purchase on the workings of the universe.

After describing the current limitations, I will suggest that neuroscience has a great deal to tell us now about some of the norms of our criminal justice.

177. RIDLEY, NATURE VIA NURTURE, supra note 82, at 269.
180. “I have . . . found out how hard it is to get to really know something, how careful you have to be about checking your experiments, how easy it is to make mistakes,” and comparing that process to the truth-claiming statements made by some social scientists who “haven’t done the work.” Richard Feynman on “Social Sciences,” MaYoMo (Dec. 16, 2009), http://mayomo.net/68362-richard-feynman-on-social-sciences.
1. Limitations Based on Imaging.\textsuperscript{181} Neuroimaging permits insight in real time into the “neural structures and processes in normal and disordered thought.”\textsuperscript{182} How does it work? Take functional magnetic resonance imaging (fMRI), for example, which provides real-time insights into the areas of the brain that are especially active in response to certain tasks:

The current model of the hemodynamic response . . . posits that a transient increase in neuronal activity within a region of the brain begins consuming additional oxygen in the blood proximal to these cells but also causes local vasodilation. As a result, blood near a region of local neuronal activity soon has a higher concentration of oxygenated hemoglobin than blood in locally inactive areas. The blood oxygen level dependent (BOLD) fMRI provides a measure of these hemodynamic adjustments and–by inference–the transient changes in neuronal activity in the proximal brain tissue.\textsuperscript{183}

To (over)simplify, fMRI uses huge magnets (calibrated in “teslas”) to measure changes in oxygen level as blood flows into areas of the brain that are activated by some stimulus.\textsuperscript{184} The evidence strongly supports the idea that brain processing demands elevated levels of oxygen in the areas of the brain where the processing occurs. Thus, as oxygen to any given area of the brain increases, the inference of relatively site specific activity increases.\textsuperscript{185} The changes are then mapped in beautiful

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\item \textsuperscript{182} Cacioppo et al., \textit{supra} note 1, at 651.
\item \textsuperscript{183} \textit{Id.}
\item \textsuperscript{184} Xuchu Weng et al., \textit{Imaging the Functioning Human Brain}, 96 PROC. NAT’L ACAD. SCI. USA 11073, 11073 (1999), available at \url{http://www.pnas.org/content/96/20/11073.full.pdf+html}.
\item \textsuperscript{185} See generally Neal Feigenson, \textit{Brain Imaging and Courtroom Evidence: On the Admissibility and Persuasiveness of fMRI}, in \textit{LAW, MIND AND BRAIN}, \textit{supra} note 65, at 23. The underlying theory of fMRI is that when neurons are active, they demand energy, which is supplied by a high energy molecule called adenosine triphosphate (ATP), which in turn is produced by oxygen and glucose in the blood. Because more oxygen is supplied to the active brain region than is consumed, the ratio of oxygenated to deoxygenated blood in the active region increases. This results in changes in magnetic resonance (MR) signal intensity, as measured by an MR scanner, because oxygenated and deoxygenated blood have different magnetic susceptibilities. The best fMRI technology today can focus on an area of the brain no larger than a grain of rice.
\end{itemize}
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(perhaps too beautiful) colors projected on a computer monitor. What gets mapped, though, is not the brain activity itself; we cannot do that. Rather, what is displayed is an artifact of brain activity plotted by algorithms to correspond to a known area of the brain. The displayed brain image can vary greatly “depending on the signal threshold, color, contrast, or ordinates the technician chooses or even the brand of machine available in a particular laboratory.”\textsuperscript{186} Moreover, images are always compared to “average” or “normal” brains and therein lie several potential difficulties: the image of any individual’s brain has to be compared to some baseline to determine if it is normal, but what is normal is neither always clear nor shared from one lab or researcher to another.\textsuperscript{187}

As if problems related to machine intensity and determining the norms of an average brain were not sufficient to cast doubt on the admissibility of fMRI displays in a single criminal case, preliminary issues related to logical relevance are also daunting. Efforts to introduce imaging evidence in the guilt phase of trial have been made in numerous cases in which claims of mental incompetence,\textsuperscript{188} insanity,\textsuperscript{189} and inability to deceive were presented.\textsuperscript{190} Among the reasons this type of evidence is either inadmissible or not convincing is the chain of inferences that must be drawn out to support the relevance of the images.

What stands in the way? Evidence presented at trial is prima facie admissible if it has “any tendency to make the existence of any fact that is of consequence to the determination of the action more probable or less probable than it would be without the evidence.”\textsuperscript{191} The trial court judge makes a preliminary determination of both relevance and whether the evidence submitted meets acceptable standards for scientific

\textsuperscript{186.} Donald Reeves et al., \textit{Limitations of Brain Imaging in Forensic Psychiatry,} 31 J. AM. ACAD. PSYCHIATRY L. 89, 90 (2003).

\textsuperscript{187.} \textit{Id.} at 90.

\textsuperscript{188.} See, \textit{e.g.}, United States v. Hammer, 404 F. Supp. 2d 676, 719 (M.D. Pa. 2005) (admitting scans from multiple imaging sources and finding credible evidence that the defendant suffered significant abuse and borderline personality disorder but finding not credible, among other things, the “conclusion that [the defendant] was not competent and not acting voluntarily, intelligently and rationally at the time of . . . the change of plea”).


\textsuperscript{191.} \textit{Fed. R. Evid.} 401.
Following the Supreme Court of the United States 1993 decision in *Daubert v. Merrell Dow Pharmaceuticals, Inc.*, the Federal Rules of Evidence were amended to state that expert evidence is admissible “if (1) the [expert] testimony is based upon sufficient facts or data, (2) the testimony is the product of reliable principles and methods, and (3) the witness has applied the principles and methods reliably to the facts of the case.” *Daubert* requires trial courts to test the reliability of proffered scientific evidence. The inquiry comes in multiple parts: (1) whether the theory or technique on which the testimony rests can be or has been tested; (2) “whether the theory or technique has been subjected to peer review and publication”; (3) whether the known or potential error rate of the theory or technique when applied is acceptable; and (4) whether the theory or technique has been generally accepted in the relevant scientific community.

Now plug in fMRI, which is “a technique [used] to image brain activity related to a specific task or sensory process.” To satisfy the standards of admissibility in a case in which the defendant, for example, seeks to introduce fMRI evidence to support a claim of inability to form the requisite mens rea, the court would have to find credible the chain of inferences running from the fMRI data to the psychological function or construct of interest. The chain of inferences runs like this:

\[
\text{fMRI data} \rightarrow \text{BOLD data} \rightarrow \text{neuronal activity} \rightarrow \text{psychological function}
\]

In other words, the court must begin with the assumption that a given area of the brain—area \(Q\)—is more likely to be activated in a well-functioning brain than in the defendant’s. That is to say, the first inference one must demonstrate runs from the fMRI data (the beautiful colors of the brain area that are highlighted on the computer screen) to the data indicating that area \(Q\) was activated. The BOLD signals in the regions of interest in the brain of the subject in whatever task the subject was asked to do while the imaging took place. Next, the proponent has to show the reliability of the second inference, which

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192. FED. R. EVID. 104(a) (stating that “[p]reliminary questions concerning the qualification of a person to be a witness ... or the admissibility of evidence shall be determined by the court”).


195. 509 U.S. at 589.

196. Id. at 593-94.


198. See Feigenson, *supra* note 185, at 32.
tracks the relationship between the BOLD signals to the neuronal activity in regions of interest in the brain of the subject in that task condition. The BOLD signal is lighting up area $Q$ of the brain. The third inference moves from the neuronal activity recorded in area $Q$ to the neuropsychological function that the proponent of the evidence is interested in. For example, area $Q$ is associated with the deficient mental activity; further, deficit affected the ability to form the requisite culpability state at $t$, the moment the crime occurred.

Again, each one of these inferences has to satisfy the screen of reliability under the appropriate scientific evidence standard and, in the case of inference (3)—from neuronal activity to neuropsychological function—the proponent has to satisfy the basic standard of the relevance of fMRI evidence for law, both of which are crucial considerations. Inference (1)—from the fMRI data to the BOLD data in the regions of interest in the brain of the subject in the task or experimental condition—is affected by the researchers’ decisions regarding, and the assumptions underlying, the data processing methods used, most of which have not yet converged on the kind of consensus that would allow the basic technology to automatically remove doubts about reliability (as have x-rays, for instance). Inference (2)—from the BOLD data to neuronal activity—is less problematic, but it is still potentially troublesome. Although the vast majority of brain researchers believe that local blood flow in the brain is related to neural activity, the precise relationship is not yet completely understood. Inference (3)—from neuronal activity to psychological function—raises fundamental questions about the theories and concepts relied upon in the design of fMRI studies and the associations drawn between fMRI data and the cognitive or emotional function of interest.199

All but a few of even its strongest proponents understand that imaging is not mind reading. Imaging can provide only post hoc explanations and thus is only one among many windows into the brain; all imaging requires interpretation.200 That this is so follows from the chain of inferences that must be drawn and the assumptions that must be made to move from an imaging artifact to satisfying the dictates of logical relevance at trial. (And in contrast to issues of mental fitness that arise in a criminal case, in civil cases, in which the issue is often one of physical injury, the admissibility of imaging evidence along with clinical

199. Id. Feigenson demonstrates the potential problems that arise each step of the way.
200. Mobbs et al., supra note 134, at 698.
assessments presents far fewer problems.\textsuperscript{201} This is not to say that neuroimaging has no current relevance in our criminal justice system, a point taken up shortly. It is to say that its use in the guilt phase of criminal proceedings is quite limited.\textsuperscript{202} As explained later, the data should be useful for changing our punishment regime.

B. Limitations on the Use of Behavioral Genetics

Behavioral geneticists study “genetic and environmental factors that create behavioral differences among individuals.”\textsuperscript{203} Adding to the complexity that is necessary to understand both its limitations and potential, human behavioral genetics looks at “estimation[s] of variance components—that is, why people’s behavior . . . differs from one person to another.”\textsuperscript{204} There are two central ideas here: “heritability,” which refers to the capacity of our genomes within a sample to pass a trait on to our progeny, and “variation,” which speaks to the contents and measures that compose the significant extent to which that capacity is influenced by random events.\textsuperscript{205} Although a tendency to criminality is heritable,\textsuperscript{206} there is no reason to believe that all of the children of


\textsuperscript{202} There is a related concern: Even if imaging technology can meet all the hurdles on the road to admissibility, Federal Rule of Evidence 403 places discretion in the hands of the trial court judge to exclude otherwise admissible evidence “if its probative value is substantially outweighed by the danger of unfair prejudice, confusion of the issues, or misleading the jury, or by considerations of undue delay, waste of time, or needless presentation of cumulative evidence.” \textsc{Fed. R. Evid.} 403. Virtually everyone who has worked with imaging displays has noted a phenomenon that some refer to informally as the “Christmas tree phenomenon”: the tendency of observers, including jurors and judges, to be overwhelmed by the pictures of the brain. Mobbs et al., supra note 134, at 699 (internal quotation marks omitted); see also Martha J. Farah, Emerging Ethical Issues in Neuroscience, 5 \textsc{Nature Neurosci.} 1123, 1127 (2002).


\textsuperscript{204} David C. Rowe & Kristen C. Jacobsen, \textit{In the Mainstream: Research in Behavioral Genetics}, in \textsc{Behavioral Genetics: The Clash of Culture and Biology} 12, 16 (Ronald A. Carson & Mark A. Rothstein eds., 1999).

\textsuperscript{205} See, e.g., Edelman, \textit{Bright Air}, supra note 15, at chs. 5-6; Stephen J. Gould, \textsc{The Flamingo’s Smile: Reflections in Natural History} 326 (1985); Ridley, \textsc{Nature via Nurture}, supra note 82, at 76-77.

\textsuperscript{206} Adopted children, for example, tend to end their lives with criminal records that far more strongly resemble their biological parents’ records than those of their adoptive parents. See, e.g., Plomin, supra note 203, at 108-10; Ridley, \textsc{Nature via Nurture}, supra
criminal parents are destined to become criminals themselves. Nor is there reason to believe that researchers will one day find a criminality gene. There is no known gene or cluster of genes that controls one's propensity for criminal conduct. It is likely that if scientists found something like a gene that conduces to criminality they would discover that the same genetic complex is necessary for the pursuit of useful endeavors. This is so because “genes do not act in a solitary manner—they act in concert with other genes, often with many genes.”

Given the interdependency of genetic and structural components of human behavior, there is reason to question the likelihood that researchers will find a direct causal link between specific genetic alleles and crimes, even though most practitioners and commentators allow that genes affect even voluntary behavior.

Professor Owen Jones makes three important points in this context. First, criminal behavior, like all of our behavior, “is influenced by both environmental and genetic forces, as well as by their interaction.” Second, genetic influences do not equate with genetic explanation: what behavioral genetics can do is provide some insight into why certain behaviors are more likely in one population than another. Finally, he notes that “[t]o say a behavior is natural, biological, or genetically influenced is never to say it is for that reason good or excusable, or automatically entitled to any legal deference or relevance whatsoever.” Certain individual assessments cannot be turned over to neuroscience in bulk because they require human judgment about the definitions of our norms and their application in particular cases. It is in this realm, however, that neuroscience has much to tell us; it can support or debunk our existing norms.

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207. PLOMIN, supra note 203, at 108.

208. There is at least one school of thought that suggests that even if this is correct, it “is unlikely to generate practical strategies” because (a) some of the responsible genes may be relevant to useful, productive behavior; (b) levels of testosterone that conduce to aggressive behavior affect numerous brain sites and therefore cannot be controlled sufficiently to prove useful in controlling aggression; and (c) any useful diagnostic procedures would be highly intrusive and over-inclusive. See Tabitha M. Powledge, Genetics and the Control of Crime, 46 BIOSCIENCE 7, 7 (1996).

209. Kenneth F. Schaffner, Genetic Explanations of Behavior: Of Worms, Flies, and Men, in GENETICS AND CRIMINAL BEHAVIOR, supra note 75, at 79, 83. But see Jones, supra note 3, at 87 (“There is no gene or set of genes (or allele or set of alleles) that are for—or directly responsible for—criminal behavior.”).


211. Jones, supra note 3, at 87.

212. Id.
C. The Promise of the New Brain Sciences

Neither neuroimaging nor behavioral genetics can tell us what went on in the mind of a killer when he killed or what his motives were. Neuroimaging fails because we commit a categorical error if we assume “that the organization of cognitive phenomena maps in a 1:1 fashion into the organization of the underlying neural substrates. . . . [M]ost complex psychological or behavioral concepts do not map into a single center in the brain.”213 Behavioral genetics also fails at the level of predicting individual behavior. Put simply, the basic tools of the trade address issues in terms of population characteristics rather than individual traits. As researchers point out, studies in behavioral genetics are helpful “in quantifying the magnitude of genetic and environmental influences, albeit in a broad, statistical manner through abstract variance components.”214 In other words, the discipline (and its cousin, behavioral ecology) produces statistical and “probabilistic information,”215 the very stuff of which behavioral norms are created.

Although the neurosciences are relatively indeterminate with respect to the causal relationship between a structural, genetic, or functional deficiency and specific criminal conduct on a specific occasion, the data sets have generated rich mines that address our behavioral norms. We can now meaningfully ask whether individuals who suffer psychopathy or reduced prefrontal cortex mass, or who grow up in abusive households and also suffer neurotransmitter deficits, are entitled to a tailored, compassionate social response that far exceeds what we now offer.216 If they are entitled to better treatment based on the norm that those who cannot completely choose otherwise are, to some extent, less blameworthy than those who can, then what should we do or at least

213. Cacioppo et al., supra note 1, at 654; accord GREENFIELD, supra note 123, at 6 (stating that “there is no simple one-to-one matching between a function and a particular part of the brain”); Mobbs et al., supra note 134, at 698.


216. Neurotransmitters control the neural pathways in the brain, the “reward” centers, the abilities to feel pleasure and pain. Studies of skin conductance among convicted criminals show that it takes longer for an electrical charge to travel down their arms, indicating a serotonic uptake disorder. Serotonin is the neurotransmitter that allows for the ability to reduce pain. If it is too low, the organism can get violent. If it is too high, the organism seeks stimulation. See, e.g., Amar Patel, Genetic Basis for Violence, http://serendip.brynmawr.edu/bb/neuro/neuro04/web2/apatel.html (last visited Mar. 11, 2011).
think about with respect thereto? Social science has made it very clear that we tend to over-blame individuals based on their poor dispositions rather than their situations, but that is only part of the issue.

1. Examples from Psychopathology and Evolutionary Theory. Professor Adrian Raine is among the nation’s leading researchers on the neurobiology of crime. His work and that of many others demonstrates that significant PFC deficits affect an individual’s propensity to commit crimes. Like the work on MAOA, Raine’s work demonstrates that genes and the environment, in combination (G × E) and separately, create both their own and reciprocal risk factors for antisocial outcomes. Specifically, Raine has shown that poor functioning of the PFC predisposes an individual to violence in a number of ways, including loss of amygdala control, enhanced tendency to risk-taking, which, from the viewpoint of personality development, is associated with impulsivity, loss of self control, and an inability to inhibit behavior—all conditions which conduce to criminal behavior.

It should not be surprising that the samples of brains from a substantial population of murderers are functionally different than those of normal people. We have known for a century or more that damage to certain areas of the brain conduce to violent behavior. The

217. There are, of course, substantial issues implicated in this statement—not the least being where lines are draw between those who can’t meet our social norms and those who won’t (between lack of ability and lack of will). These are not easy questions to answer, and I offer only partial answers in this Article. Moreover, if we hue to a new model of rehabilitation for those who we believe can’t, what should we do with them? For how long can they be incapacitated and under what conditions? If we conclude that early childhood interventions are appropriate, how can we safeguard the privacy of those in whose lives we intervene?

218. See Blumoff, The Problems with Blaming, supra note 65, at ch. 6.


223. Id.
story of Phineas Gage has been told and retold often. Yet, anyone who has ever visited a nursery in the neonatal section of any hospital knows that those six, seven, and eight pound bundles of humanity were not born evil. They may have been born with certain deficits, but they had to grow into evilness; for that development we are all responsible.

From the perspective of evolutionary psychology, complementary findings have emerged. The lifelong work of Martin Daly and the late Margo Wilson underscores the relationship between evolution and crime that is frequently present. Their work indicates the presence of “evolved motivational mechanisms of all creatures, including ourselves, [that were] designed to expend the organism’s very life in the pursuit of genetic posterity.” A tendency of selection is “to facilitate behavioral choices with the best expected fitness consequences in ancestral environments.” For example, the researchers compared family homicide rates between parent-child relationships and spousal relationships. They understood that the “parent and child are genetic relatives with an indissoluble overlap in expected fitness . . . of marriage partners.” In contrast, any fitness overlap between spouses “is predicated on reproduction and sexual fidelity.” In fact, the sources of conflict between the two relationships are very different. Their research (in which the confounding variable of opportunity “within-household” violence is held constant) shows a statistically-significant distinction between genetic and marital homicides: “[R]ates of homicide by victim-killer relationship category were vastly higher both for spouses and for other co-residing persons who were not genetic relatives than for any category of blood kin;” thus, the evidence supports the thesis that there is nepotistic discrimination in some victim-killer relationships.

It seems as if selection has outfitted us with two competing tendencies: in some individuals, there may be a strong evolutionary tendency to commit (or at least tolerate the commission of) crime as a means of maintaining fitness. At the same time, however, we seem to harbor even

224. See, e.g., Hanna Damasio et al., *The Return of Phineas Gage: Clues About the Brain from the Skull of a Famous Patient*, 264 SCIENCE 1102 (1994).
227. Id. at 64.
228. Id.
229. Id. Daly and Wilson found that most inter-spousal homicide entailed male proprietariness, whereas the motives for most infanticide vary depending upon age, gender, and other variables. See Martin Daly & Margo Wilson, *Evolutionary Social Psychology and Family Homicide*, 242 SCIENCE 519 (1988).
stronger tendencies to strike back at such tormentors. As Raine points out, “Whether or not there is a genetic or a biological predisposition to violence, when a violent crime is committed, we want to blame someone.” Evolution, then, has equipped us to kill to further our genetic aims in what appear to be conflicting ways: to kill when fitness goals are implicated and to pursue an immediate and sometimes ruthless defense against wrongdoing, whatever its motive. A task of neuroscience is to bring into the forefront a third psychological quality that evolution has provided us: compassion and forgiveness.

2. Evidence from Behavioral Genetics and Neuroscience. The MAOA research confirms what many of us have always known: there is a subset of violent individuals who, through no fault of their own, seem less free than the rest of us when it comes to controlling their actions, and they are less free because some genetic or neurochemical deficit, combined with a physically or sexually abusive or persistently neglectful toxic environment, produces a statistically significant greater likelihood of violence and trouble with the law. We have known for a long time that a child raised in an abusive environment is more likely to become abusive himself, just as we have known for a long time that “[c]riminal parents produce criminal children–yes, but [less often] if they adopt the children.” Biologically “bad” genes are generally not, like certain medications, formulated to take effect at some point in the

230. Raine, Murderous Minds, supra note 222.
231. See John L. Mackie, Morality and the Retributive Emotions, 1 CRIM. JUST. ETHICS 3 (1982) (surveying the various forms retribution can take but suggesting that retributive emotions promote cooperation in the long, evolutionary, run).
232. Although the data provided in this Article is mostly neuroscientific, this new data stands on the shoulders of less technical observations. The sociology of this problem still has deep roots in our modern history. Some recent epidemiological surveys support this point. For a discussion on the relationship between childhood spent in an impoverished, abusive environment and health generally, see Emalee G. Flaherty et al., Effect of Early Childhood Adversity on Child Health, 160 ARCHIVES PEDIATRICS ADOLESCENT MED. 1232 (2006), available at http://archpedi.ama-assn.org/cgi/content/full/160/12/1232 (finding with exposure to child abuse and neglect other serious household dysfunction at ages four to six was associated with overall poor health outcomes, although there was no dose-response relationship) and Crystal Wiggins et al., Literature Review: Developmental Problems of Maltreated Children and Early Intervention Options for Maltreated Children, U.S. DEPT OF HEALTH & HUM. SERVS. (Apr. 23, 2007), available at http://aspe.hhs.gov/hsp/07/Children-CPS/litrev/report.pdf (recording studied differences in developmental, cognitive, and health problems, among others).
233. Widom & Brzustowicz, supra note 151, at 684.
234. RIDLEY, supra note 82, at 253.
future; “a bad environment is also required” and vice versa. We can, with help, escape or help others escape bad environments.

And for those who cannot escape? We should understand that some individuals with organic impairments who do not attain the level of gross and verifiable psychopathology that permits an excuse for criminal liability really cannot stop themselves, yet they fall somewhere short of grossly pathological on the normal-abnormal scale. We humans do not fit into neat binary cabins that reflect differences between capacity and volition. We expect that individuals who suffer substantial non-psychopathological deficits and have some knowledge of their maladies mark those deficits off, segregate them in some way, and behave forever after in conformity with law. Unlike us, they lack complete free will and cannot "shoulder the responsibility of keeping that organic impairment within the confines of its boundaries." Individuals with damaged brains do not operate that way.

What the literature about the PFC shows is that there is a reductive, materialistic neurobiology to the containment, resulting in the potential for volitional control to be impaired just as unambiguously as any other aspect of brain function. It is possible to know the difference between right and wrong but, for reasons of organic impairment, to not be able to do the right thing.

Moreover, injuries suffered in infancy and early childhood may preclude forever their ability to reason in a social and moral context.

The essential point here is that we do not experience the world without some changes in our neuroanatomy for good and ill. That is how we are made. Experiences effect changes in, among other things, the way in which neurotransmitters—the basic stuff of communication among nerve cells—operate in conjunction with the receptors waiting to receive them. Changes in the environment, especially but emphatically not measured only by exposure to toxins, bear upon the way we interact with the world. Ordinarily, the process by which these changes are made and, subsequently, by which memories are created, are benign or at least not harmful in the long term. Repeated instances of a harmful

235. Id. at 268.
236. Sapolsky, supra note 2, at 1793.
237. Id. at 1793-94.
238. See generally Abigail A. Baird & Jonathan A. Fugelsang, The Emergence of Consequential Thought: Evidence from Neuroscience, 359 PHIL. TRANSACTIONS ROYAL SOC’Y LONDON B. 1797 (2004) (discussing behavioral and neuroscientific approaches to the ability to think counterfactually about the consequences of one’s actions, which is at the center of the law’s approach to criminal responsibility).
environment, however, literally can and do alter an individual’s ability to conform to societal norms.

It is just wrong, then, to suppose that genes alone cause crime; they do not. As noted before, there is no isomorphic correspondence between specific, unalloyed brain structures and particular behavior, notwithstanding that a handful of genetically-linked diseases might suggest a contrary understanding. “[A]ny one function depends on the contributions of many brain areas, yet any one brain area will participate in any number of diverse functions.”239 At the same time, it is entirely accurate to say that individual temperament begins to be formed shortly after conception as the fetus responds to his or her environment. Adrian Raine summarizes the interdependence among genes, the environment, and the tendency to criminality:

[W]hen biological and social factors are grouping variables and when antisocial behavior is the outcome, then the presence of both risk factors exponentially increases the rates of antisocial and violent behavior. . . . [W]hen social and antisocial variables are grouping variables and biological functioning is the outcome, then the social variable invariably moderates the antisocial-biology relationship such that these relationships are strongest in those from benign home backgrounds.240

Raine’s summary is almost a call to arms.

IV. Getting Serious About the Brain

In light of our history of misusing scientific data to move public policy, we have good reason to be cautious. History contains countless instances of abuse and, too often, of irremediable injury.241 The same ability, however, to affect our development in countless unique ways includes within it the capacity to move us in a generally more compassionate direction than we now move. We can shift the boundary away from reinforcing a lack of empathy toward one that hopes to redirect and rehabilitate as many injured individuals as we can. In other words, we have within us today the ability to affect for the long term the daily circumstances of our lives. Then what? We could do nothing, which would still deliver something; the prevailing ethos always does. If we can move in a more compassionate direction, we will change for the

239. GREENFIELD, supra note 123, at 6.
better the location of the midpoint for the least well-off among us. Individual development depends entirely upon how one adapts to one’s own unique environments, when the composition of the environment includes everything that is not within our inherited genotype. If we fail, it is because we lack the good will to move forward.

A. What Can Work?

Judge Michael Marcus, a state trial court judge in Oregon, notes the basic problem with our approach to sentencing and our deplorable recidivism rates:

Legislation and ballot measures have responded to concerns about crime with draconian sentencing provisions that limit judicial discretion. But our litany elevates punishment well beyond its practical utility, allowing criminal justice to compete unfairly with social expenditures far more productive of crime prevention. We persist in this dysfunction while lamenting, ironically, that repeat offenders do not seem to learn from their experience.242

Put simply, our ties to dualism and the nearly irrebuttable presumption that “they could have chosen otherwise,” combined with the mire of retributivism and the easy political chant of “get tough on crime,” continue to undermine our own self-interest. Lawrence Sherman and others list a number of alternatives that have produced promising results: vocational training for older male ex-offenders; nuisance abatement action on landlords for rental housing with drug dealing; extra police patrols for high-crime hot spots; monitoring by specialized police units for high-risk repeat offenders; incarceration; on-scene arrests for domestic abusers who are employed; rehabilitation programs with risk-focused treatments for convicted offenders; and therapeutic community treatment programs for drug-using offenders in prison.243

Although there are numerous reasons given for the continuation of the long unsuccessful “get tough on crime” regime (including, in many instances, the same lack of success concerning the socio-pathology of drug related crime), among the most frightening conclusions we can reach is that with respect to rehabilitation nothing works,244 which was the litany of unreliable science that often defined the 1980s. Only

slightly less general is the lamentable reality “that we routinely make sentencing choices without information that would help us choose that disposition most likely to avoid future victimizations.”

That nothing works was a vast overstatement. Some approaches do work, but they require careful attention to control over a number of details, including careful attention to the risks that conduce to criminal behavior; the empirical support for those programs that do work, and the careful identification of those for whom such programs are most successful. Then, of course, competency and consistency in delivering the programs have to be assured as does a commitment to determining how to sustain the ethic over time.

Beyond all that, nothing will get accomplished in changing the current state of affairs without good will, a goal that is now unimaginably far from our current state of affairs. (This lack of good will is also unimaginably further from reality than at any prior time in my life.) Legislators and penal administrators have it in their means to fund the kind of responses to criminality that could make us all safer as we go to sleep at night. Instead, the emphasis on “get tough” measures has created its own vicious dynamic. Retribution, which is to some extent inescapable in any system of punishment that necessarily begins by looking backwards, is not alone (or perhaps ever) the answer for moving forward. With information arriving from neuroscience and elsewhere, we should begin to bring more thoughtful and successful rehabilitative measures to the forefront of corrections. Bringing this information to the front lines of corrections requires substantial rethinking for our punishment theory and, if we do so, we advance Lincoln’s understanding of the better angels of our nature.

Escaping the current retributive regime will not be easy. In his essay Morality and the Retributive Emotions, J.L. Mackie describes our
unwillingness to challenge the established moral arrangements as an instantiation of "the supposed objective prescriptivity of moral features."  

Mackie would not assert that we can find an objective account of moral qualities or facts; he repudiates this kind of foundationalism. Instead, he observes correctly that our moral intuitions "are developed by social interactions and then, through objectivization, yield the misleading appearance of objective reality."  

In the domain of moral philosophy on which our criminal law rests, one of those truths is that citizens in a liberal democracy begin their journey to a vision of civic virtue from different places. As individuals, we venture into moral philosophy only after we are "already immersed in the assumptions and precedents of a tradition . . . . [They are] not so much arbitrary as inescapable: . . . shaped by the grammar of our native tongue."  

One should add, in the nature of our beings.

I would like to make use of our language and our deeply-held beliefs about human possibility to suggest a more compassionate approach to punishment, one that retains responsibility as the core concept but advances the goal without necessarily (or fully) blaming the offender, at least for offenders who substantially lack capacity-in-fact or opportunity. The question is not whether those who are adjudicated guilty beyond a reasonable doubt for misconduct we deem criminal and who present a risk of harm to the first or second order interests of others should be segregated and constrained for an appropriate amount of time.  

So much is obvious. The two questions are as follows: First, how, given the visible effects of our neurobiology and, consequently, the vast expanse of our lives over which we have little if any control, are we best served in accounting for the crucial fraction of self over which some citizens lack either capacity-in-fact or the experiences conducive to sufficient control, understanding that control or lack of control is a difficult determination? Second, can we accomplish some movement toward a more compassion-


251. Id.


253. See Michael D. Bayles, Punishment for Attempts, 8 SOC. THEORY & PRAC. 19, 23 (1982) (distinguishing between the nature of the interest the putative criminal invades, first or second-order, in which completed crimes violate a first-order interest; that is, the harm violates the interest in life, liberty, or property, and attempted crimes, in contrast, violate second-order interests, the freedom from fear of loss of a first-order interest, or security).
ate polity consistent with our normatively honorable and shared commitment to love and protect our neighbors.\textsuperscript{254} Therefore, in addition to changing our approach to corrections, we should give serious consideration to some thoughtful suggestions about (1) changing some of our burdens of proof, (2) adding some robustness to our understanding of rationality and diminished capacity, and (3) bringing the new neuroscientific data to our definition of insanity. The point here is that data from the new brain sciences can help determine whether individuals possess "particular capacities" that our current jurisprudence requires.\textsuperscript{255} For example, Terry Maroney, with others, has made a strong case for recognizing the full role emotions play in our understanding of competence, yet that role is routinely marginalized in our law.\textsuperscript{256}

As the Supreme Court recently made clear, most states still use some version of the \textit{M'Naghten} rule\textsuperscript{257} for insanity, which emphasizes lack of cognition alone as a condition for establishing insanity.\textsuperscript{258} How can anyone possibly prioritize cognitions without emotional input? It is true that differentiating between "can't" control and "won't" control presents a particularly difficult distinction to make, but it is not impossible. We ask our mental health professionals to make even more difficult decisions daily, such as predicting future dangerousness for purposes of involuntary civil commitment or post-conviction and sentencing commitment.\textsuperscript{259} As Damasio and others point out, individuals who

\textsuperscript{254} I addressed this issue several times in a narrower context. \textit{See, e.g.}, Blumoff, \textit{An Essay on Liberalism}, supra note 6.


\textsuperscript{257} \textit{M'Naghten's Case}, (1843) 8 Eng. Rep. 718 (H.L.).

\textsuperscript{258} Clark v. Arizona, 548 U.S. 735, 750-51 & nn.12-21 (2006). The lack of cognition in the original \textit{M'Naghten} rule had two dimensions: one addressing knowledge of the nature and quality of one's act and the other emphasizing knowledge that what the defendant was doing was wrong. One is excused from crime if "the party accused was labouring under such a defect of reason, from disease of the mind, as not to know the nature and quality of the act he was doing, or as not to know that what he was doing was wrong." \textit{M'Naghten's Case}, 8 Eng. Rep. at 718 (H.L.).

\textsuperscript{259} \textit{See, e.g.}, Kansas v. Hendricks, 521 U.S. 346, 355 n.2 (1997) (holding that state sexual predator statutes that rely on such predictions do not violate due process, despite the understanding "that it was not possible to predict with any degree of accuracy the future dangerousness of a sex offender"); Barefoot v. Estelle, 463 U.S. 880, 896-903 (1983)
suffer sub-psychopathological deficits to discrete neurological areas of the brain may be fully able to tackle problems of logic, and yet “many of their personal and social decisions are irrational, more often disadvantageous to their selves and to others than not.”

Some doctrine that gives scope to these obviously important observations is in order.

B. Why Finding Something that Can Work Matters

The law moves from day to day by following a fairly strict calendar, which is an absolutely necessary process. That necessity, however, leaves precious little time for practitioners to step back and ask big questions. As a result, basic principles are adhered to and are left mostly unquestioned. From time to time, we should return to basic principles, to the foundations of our commitment to a shared public theology. We can and must reorient the perspective for judgment by taking seriously our commitment to compassion. It is fundamental to Judeo-Christian ethics—“love your neighbor as yourself.”

We profess to honor compassion. I suggest that we actually practice compassion to fill the void left when blame and shame are inappropriate responses to wrongdoing, and they are inappropriate when that which should exist as natural parts of any psychologically healthy person—the capacity for empathy and the ability to control one’s conduct—are absent. The model we ought to subscribe to follows the instructions of Hillel, which proclaims our a posteriori maxim of universal compas-

(holding that psychiatric predictions of future dangerousness are admissible despite protests from the American Psychiatric Association).


263. See William J. Prior, Compassion: A Critique of Moral Rationalism, 2 PHIL. & THEOLOGY 173, 178 (1987); see also James E. Gilman, Compassion and Public Covenant: Christian Faith in Public Life, 36 J. CHURCH & ST. 747, 766 (1994) (noting that compassion implicates public policy in two ways—one preventative and one curative— and both should prevent the adoption of policies that cause “involuntary, social suffering” and alleviate suffering where it already exists).
sion negatively: “What is hateful unto you, don’t do unto your neighbor. The rest is commentary—now go and study.”

The suggestions put forth in the previous section provide a starting point for a new system to operate. The regime I envision initially suspends blame and begins at a biographically earlier point in time. The regime hopes to determine who the person is who deserves our harshest treatment, not merely whether he committed the crime. We should view the propriety of punishment or treatment in a given case as dependent upon scoring on two axes: one axis measures capacity-in-fact, the other axis measures opportunity and its use. On the first axis, the questions address cognition and control: either the wrongdoer has or does not have sufficient cognitive skills to know right from wrong, and he either can or cannot control his behavior. If he lacks either, he lacks capacity-in-fact. Although neuropsychological testing and brain imaging may not be perfect, they can provide useful insights into an individual’s brain functioning. The other axis addresses socioecconomic and educational opportunity: one does or does not have such opportunities, and if he has had sufficient opportunity, he either did or did not make appropriate use of them in the past. Under this proposal, meeting the demands of minimum instrumental reasoning—effecting a simple syllogism—simply indicates that the actor should remain in the standard criminal justice system. For those unable even to effectuate a simple practical syllogism, cognitive competency remains an issue; that is to say, blameworthiness is surely compromised and psychiatric treatment and incapacitation may still be required.

Thus, those who have ample cognitive capacity, emotional control, and good fortune but fail to make use of it are, prima facie, the most culpable both morally and intuitively; when compared to those who are cognitively, emotionally, or experientially deprived, they more likely could have done otherwise (their crimes may also be the most deterrable).


265. It is worth noting again that the metrics to make such determinations are not easy to achieve. Neuropsychological testing is in its infancy. Nevertheless, if we approach the questions with a view toward rehabilitation rather than retributive punishment, we may gain new insights into how we make these decisions.


267. See, e.g., United States v. Bergman, 416 F. Supp. 496, 500 (S.D.N.Y. 1976) (noting that a brief period of incarceration for wealthy, well-educated older men who plead guilty to multiple state and federal counts of criminal deliberate non-impulsive fraud “are among
contrast, those who lack both capacities and suffer bad luck are the least blameworthy for, prima facie, they could not have done otherwise. In the middle are those who possess sufficient cognitive skill and capacity-in-fact but lack the opportunity to adapt appropriately or lack the capacities but have been blessed with good opportunities. They may well require restraint but probably not blame, and certainly they do not require vengeful, retributive treatment. For all such groups, education and treatment during their period of incapacity are the only meaningful moral alternatives if protecting future generations is our goal.

C. Moving Ahead: Taking the Brain Seriously

This work began by setting out a view of our criminal jurisprudence that has been substantially unchanged since Descartes set us on the path to an unforgiving dualist view of humankind. That view, coupled with the rediscovery of Aristotle, led us to the neurobiologically naive Humean view that we are all responsible for our own characters such that when one does an evil deed, one is almost always deemed to have ample capacity to choose that act. Findings from the brain sciences have put that dictum to the test. Some among us suffer major deficits that do not rise to the law’s test of gross and verifiable psychopathology.

The contention that an injury can amount to a crime only when inflicted by intention is no provincial or transient notion. It is as universal and persistent in mature systems of law as belief in freedom of the human will and a consequent ability and duty of the normal individual to choose between good and evil.\(^{268}\)

In the same paragraph of the Supreme Court’s decision in Morissette v. United States,\(^{269}\) Justice Jackson lamented the “tardy and unfinished substitution of deterrence and reformation in place of retaliation and vengeance as the motivation for public prosecution.”\(^{270}\) The ability to choose between good and evil is the moral base of our criminal law: “I have put before you life and death, blessing and curse. Choose life . . . .”\(^{271}\) Hebrew scripture tells us that “even though we have the ability to do evil, we should not do evil. We should do good.”\(^{272}\)
For nearly two hundred years, we have known that some individuals who are adjudicated competent and sane nonetheless lack the wherewithal to choose good. Observers have noted the relationship between injury to the prefrontal lobes, mostly the orbitofrontal cortex and “poor impulse control, explosive aggressive outbursts, inappropriate verbal lewdness, jocularity, and lack of interpersonal sensitivity.”

Scientific evidence of dysfunction in the amygdala has been associated with violent aggressive behavior for nearly a generation. Furthermore, we have known that many children who have been subjected to abuse or neglect early in their lives bear emotional scars that sometimes do not go away, and they often suffer brain dysfunctions that conduce to a life of violence and criminality. The only remaining question is this: when will our criminal justice system take seriously what we have known to be the case almost forever? There are individuals who could not do otherwise, and punishing them—as opposed to incapacitating and treating them—fails our basic standard of morality.


274. See, e.g., LeDoux, THE EMOTIONAL BRAIN, supra note 137, at chs. 6-7; Laurence Tancredi, HARDWIRED BEHAVIOR: WHAT NEUROSCIENCE REVEALS ABOUT MORALITY 34-36 (2005) (noting that the amygdala circuit stores emotional memories and makes quick assessments of the environment through connections to sensory cortex and the PPC); R.J.R. Blair, The Roles of the Orbital Frontal Cortex in the Modulation of Antisocial Behavior, 55 BRAIN & COGNITION 198 (2004) (finding a strong connection between amygdala dysfunction and psychopathic behavior); Mobbs et al., supra note 134, at 699.

275. Ferguson, supra note 155 (analyzing thirty-eight published articles based on more than fifty observations between 1996 and 2006 in behavioral genetics that genetics contributes substantially to the development of antisocial personality and behavior); Teicher, supra note 162 (suggesting that abuse disrupts functioning of the limbic system, “a collection of interconnected brain nuclei (neural centers) that play a pivotal role in the regulation of emotion and memory,” and especially the hippocampus, which is important in retrieving memories, and amygdala, which plays a prominent role in creating the emotional subject matter of memory, such as fear and aggressive responses thereto); Widom & Brzustowicz, supra note 151.