VIOLENCE ON THE BRAIN: A CRITIQUE OF NEUROSCIENCE IN CRIMINAL LAW

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Is there such a thing as a criminally "violent brain"? Does it make sense to speak of "the neurobiology of violence" or the "psychopathology of crime"? Is it possible to answer on a physiological level what makes one person engage in criminal violence and another not, under similar circumstances?

Current research in law and neuroscience is promising to answer these questions with a "yes." Some legal scholars working in this area claim that we are close to realizing the "early criminologists' dream of identifying the biological roots of criminality." These hopes for a neuroscientific transformation of the criminal law, although based in the newest research, are part of a very old story. Criminal law and neuroscience have been engaged in an ill-fated and sometimes tragic affair for over two hundred years. Three issues have recurred that track those that bedeviled earlier efforts to ground criminal law in brain sciences. First is the claim that the brain is often the most relevant or fundamental level at which to understand criminal conduct. Second is that the various phenomena we call "criminal violence" arise causally from dysfunction within specific locations in the brain ("localization"). Third is the related claim that, because much violent criminality arises from brain dysfunction, people who commit such acts are biologically different from typical people ("alterity" or "otherizing").

This Article first demonstrates parallels between certain current claims about the neurobiology of criminal violence and past movements that were concerned with the law and

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neuroscience of violence: phrenology, Lombrosian biological criminology, and lobotomy. It then engages in a substantive review and critique of several current claims about the neurological bases of criminal violence. Drawing on research and interviews with neuroscientists, this Article shows that causally localizing what we call "criminal violence" to bits of the brain is scientifically contestable and epistemologically untenable. In viewing the criminal law-neuroscience relationship through the lens of history of science, this Article hopes to offer a constructive portrait of how current neuroscience might inform criminal law discourse about regulating violence.

INTRODUCTION

Is there such a thing as a criminally "violent brain"? Does it make sense to speak of "the neurobiology of violence"[1] or the "psychopathology of crime"?[2] Is it possible to answer on a physiological level what makes one person engage in criminal violence and another not, under similar circumstances?

Current research in law and neuroscience is promising to answer these questions—and to answer each of them with a "yes." Several scholars working in this area claim that we are "close[ ] to realizing the early criminologists' dream of identifying the biological roots of criminality."[3] They urge not that some criminals suffer from mental diseases but that "crime [is] a disease"[4] that the criminal law should, across the board, "adopt a disease theory view of crime."[5] This "disease" of violent crime does not arise from metaphorically "sick" personal choices or social conditions; rather, some claim that neuroscientists have discovered in criminal offenders a "'biological brain-proneness' toward violence" that substantially explains the existence of violent crime.[6]

The current, hopeful claims about the discovery of biological

1. JAN VOLAVKA, NEUROBIOLOGY OF VIOLENCE 2 (1995).

2. ADRIAN RAINE, THE PSYCHOPATHOLOGY OF CRIME: CRIMINAL BEHAVIOR AS A CLINICAL DISORDER 3–4 (1993).

3. Richard E. Redding, *The Brain-Disordered Defendant: Neuroscience and Legal Insanity in the Twenty-First Century*, 56 AM. U. L. REV. 51, 56 (2006).

4. Jeffrey L. Kirchmeier, *A Tear in the Eye of the Law: Mitigating Factors and the Progression Toward a Disease Theory of Criminal Justice*, 83 OR. L. REV. 631, 730 (2004). Kirchmeier's thesis is that neuroscience shows the incoherence of notions of free will and, thus, that the criminal law should substitute a "disease theory" for traditional notions of choice and blame. *See id.* ("[I]n the future our descendants will see crime the way we currently see diseases.").

5. *Id.* at 728.

6. Redding, *supra* note 3, at 56 (quoting Nathaniel J. Pallone & James J. Hennessy, *Brain Dysfunction and Criminal Violence*, SOC'Y, Sept.-Oct. 1998, at 22, 22).

roots of criminality are part of a very old story. Criminal law and neuroscience[7] have been engaged in an episodic and ill-fated love affair for over two hundred years. In each era, it starts with bold promises and a belief in the genuine mutual compatibility of the two fields, but ends in disappointment and even tragedy. With every resurgence in this mutual infatuation, lawmakers and scientists swear that they will not make the same mistakes this time—principally because this time, science has finally matured.

The fraught relationship between criminal law and neuroscience is worth re-examining now, in light of its history, because we are at a moment of renewed infatuation. Indeed, we are at the threshold of what some claim is no less than a neuroscientific revolution within law that promises biologically-based explanations of general features of human conduct.[8] This new movement carries forward some of the suspect epistemology of the prior movements—but it also contains more real potential. A careful understanding of the epistemic traps of the past and their relationship to certain current ways of framing the brain-criminal law relationship will help integrate neuroscience with law in ways that can enhance specific doctrines within criminal law and evidence, although in a more bounded fashion than some of the movement's strongest proponents might claim.

Neuroscience evidence and principles have already begun to find their way into criminal adjudications[9] and criminal law

7. The term "neuroscience" is of recent coinage and is anachronistic when applied to the brain sciences of earlier eras; however, I use it throughout this Article as a convenient umbrella term for both current and past scientific investigations of human brain structure and function.

8. *See, e.g.*, S. Zeki & O.R. Goodenough, *Law and the Brain: Introduction*, 359 PHIL. TRANSACTIONS ROYAL SOC'Y LONDON B: BIOLOGICAL SCI. 1661, 1661 (2004) (calling development of neurolaw an all but "ineluctable consequence of the current assault on the secrets of the brain").

9. To date, neuroscience evidence primarily has been offered by the defense in mitigation at sentencing. *See, e.g.*, Mosely v. Quarterman, No. 3:03-CV-1577-N, 2008 WL 656887, at *18 (N.D. Tex. Mar. 6, 2008) (rejecting defendant's ineffective assistance of counsel claim predicated on counsel's failure to identify defendant's "frontal lobe impairment"); Mashburn v. State, No. CR-06-0328, 2007 WL 3226600, at *11 (Ala. Crim. App. Nov. 2, 2007) (reviewing capital sentence; holding that lower court appropriately weighed all evidence in sentencing where it provided funds to defendant for MRI brain evaluation and reviewed MRI findings indicating no structural brain abnormalities); People v. Page, 186 P.3d 395, 413 (Cal. 2008) (discussing, in appeal of capital sentence, defendant's proffer of MRI evidence showing cyst in temporal lobe and numerous brain lesions); People v. Kraft, 5 P.3d 68, 98 (Cal. 2000) (describing introduction of PET scan as mitigating evidence showing defendant's brain abnormalities); People v. Holt, 937 P.2d 213, 231 (Cal. 1997) (admitting PET and EEG scans as mitigating evidence in capital case); Rogers v. State, 783 So. 2d 980, 998–99 (Fla. 2001) (upholding trial court's grant of funds for MRI brain scan for defendant's mitigation case); Hoskins v. State, 735 So. 2d 1281, 1281 (Fla. 1999) (vacating death sentence based on trial court's failure to allow PET scan as mitigating evidence); United States v. Polizzi, 549

scholarship.[10] This explosion of interest in neuroscience to illuminate the (presumably universal) workings of the human mind has spawned a host of neuro-fields—from neuroethics,[11] neuroeconomics,[12] and neurohistory,[13] to neurolaw[14] and neurojurisprudence.[15] Contributions to law from these emerging, hybrid fields may be substantial. Neuroeconomics, in concert with behavioral economics, is constructing more realistic and robust

F. Supp. 2d 308, 325–26 (E.D.N.Y. 2008) (allowing admission at trial in child pornography case MRI evidence of defendant's alleged brain abnormalities).

10. Since 2000 alone, over 200 articles have appeared in law reviews on the subject of criminal law and neuroscience, ranging from neuroscience-based explanations for the persistence of retributivism, *see* Morris B. Hoffman, *Rediscovering the Law's Moral Roots*, 103 NW. U. L. REV. COLLOQUY 13, 14–15 (2008), to arguments for raising the age until which the criminal system will treat an offender as a juvenile, *see* Richard F. Walsh, *Raising the Age for Juvenile Jurisdiction in Illinois: Medical Science, Adolescent Competency, and Cost*, 39 LOY. U. CHI. L.J. 767 (2008). A small sample of notable works in this very broad area includes, for example, Martha J. Farah & Paul Root Wolpe, *Monitoring and Manipulating Brain Function: New Neuroscience Technologies and Their Ethical Implications*, HASTINGS CTR. REP., May-June 2004, at 35; Joshua Greene & Jonathan Cohen, *For the Law, Neuroscience Changes Nothing and Everything*, 359 PHIL. TRANSACTIONS ROYAL SOC'Y LONDON B: BIOLOGICAL SCI. 1775 (2004); Morris B. Hoffman & Timothy H. Goldsmith, *The Biological Roots of Punishment*, 1 OHIO ST. J. CRIM. L. 627 (2004); Stephen J. Morse, *Determinism and the Death of Folk Psychology: Two Challenges to Responsibility from Neuroscience*, 9 MINN. J. L. SCI. & TECH. 1 (2008); O. Carter Snead, *Neuroimaging and the "Complexity" of Capital Punishment*, 82 N.Y.U. L. REV. 1265, 1287 (2007); Zeki & Goodenough, *supra* note 8.

11. *See, e.g.*, MICHAEL S. GAZZANIGA, THE ETHICAL BRAIN: THE SCIENCE OF OUR MORAL DILEMMAS, at xv, xviii–xix (2006) (defining neuroethics as the study of the relationship between ethical reasoning and in-built brain mechanisms or patterns; arguing that there is a universal ethical template built into the brain); *cf.* Mary Midgley, *Do We Ever Really Act?*, *in* THE NEW BRAIN SCIENCES: PERILS AND PROSPECTS 17, 21–23 (Dai Rees & Steven Rose eds., 2004) (arguing that while people self-evidently use their brains for ethical reasoning, the content of ethical judgments is not biologically encoded into people's brains). Several prominent universities have founded centers for neuroethics. *See, e.g.*, NEUROETHICS, http://neuroethics.upenn.edu (last visited Mar. 4, 2009). There is also a widely-read Neuroethics & Law Blog. *See* Blog, Neuroethics & Law Blog, http://kolber.typepad.com (last visited Mar. 4, 2009).

12. *See, e.g.*, Morris B. Hoffman, *The Neuroeconomic Path of the Law*, 359 PHIL. TRANSACTIONS ROYAL SOC'Y LONDON B: BIOLOGICAL SCI. 1667 (2004); Paul J. Zak, *Neuroeconomics*, 359 PHIL. TRANSACTIONS ROYAL SOC'Y LONDON B: BIOLOGICAL SCI. 1737 (2004).

13. DANIEL LORD SMAIL, ON DEEP HISTORY AND THE BRAIN (2008) (arguing that the field of history should be expanded to include "neurohistory"). Smail contends, generally, that aspects of human prehistory can be divined from the structure of, and inheritance evidenced by, our brains. *Id.*

14. Jeffrey Rosen, *The Brain on the Stand*, N.Y. TIMES, Mar. 11, 2007, (Magazine) at 48 (coining "neurolaw" to describe uses of neuroscience in lawmaking and in legal doctrine).

15. Redding, *supra* note 3, at 53 (arguing that the criminal law must develop "neurojurisprudence" to account for knowledge being developed in the brain and cognitive sciences).

models of individual, group, and market behavior, with potentially profound implications for the design of legal institutions.[16] The neuroimaging of pain may influence legal doctrines from tort and disability to the death penalty and torture.[17] And work on the relationship between emotion and decision making may cause legal scholars and philosophers to re-examine the relative importance of, and relationships between, emotional and reason-based methods of decision making.[18]

Moving far beyond that, however, some important voices make more imperialistic claims, arguing that we will be able to craft social regimes built on "universal morals possessed by all members of our species . . . a brain-based philosophy of life."[19] It is the contention of this Article that overreaching claims about the relationship between individual neurobiology and criminal violence can undo the productive contributions that neuroscience could otherwise make to the criminal law. Because such claims exceed what the data show, early legal adopters of more extreme forms of "neurolaw" could create a backlash against neuroscience findings. Perhaps most importantly, overreaching claims about the applicability of neuroscience may lead to misapplications similar to those of prior episodes of the criminal law-neuroscience story.

The central tenets of some current work on the criminal law and neuroscience of violence are similar to those that underlay, and ultimately undermined, past movements. This Article will argue that these tenets, and the problems inherent in them, are:

16. Among many other fine works, see, for example, PAUL W. GLIMCHER, DECISIONS, UNCERTAINTY, AND THE BRAIN: THE SCIENCE OF NEUROECONOMICS (2003); Claire A. Hill & Erin Ann O'Hara, *A Cognitive Theory of Trust*, 84 WASH. U. L. REV. 1717, 1720 (2006) (applying cognitive and behavioral theories of "optimal trust" to the design of legal institutions); Dan M. Kahan, *The Logic of Reciprocity: Trust, Collective Action, and Law*, *in* MORAL SENTIMENTS AND MATERIAL INTERESTS: THE FOUNDATIONS OF COOPERATION IN ECONOMIC LIFE 339–78 (Herbert Gintis et al. eds., 2005); Paul J. Zak, *Neuroeconomics*, *in* LAW AND THE BRAIN 133–53 (Samir Zeki & Oliver Goodenough eds., 2006).

17. *See, e.g.*, Adam J. Kolber, *Pain Detection and the Privacy of Subjective Experience*, 33 AM. J.L. & MED. 433, 433–34 (2007) (arguing for use of neuroimaging evidence of pain in litigation); Amanda C. Pustilnik, Seeing Pain, Measuring Value(s): Neuroimaging Pain from Tort to Torture (unpublished manuscript, on file with author) (collaborating with neuroscientists to explore legal consequences of pain imaging). The notion of the chronic pain patient as suffering from "conversion hysteria" or "accident neurosis" may be largely undone by advances in identifying neural mechanisms of pain chronification, putting to rest one of the last golems of Freudianism in the law. Hank Greely and Stephen Morse also are exploring the relationship between pain neurobiology and law in a forthcoming work.

18. *See, e.g.*, Oliver R. Goodenough, *Institutions, Emotions and Law: A Goldilocks Problem for Mechanism Design* (Vermont Law Sch. Berkman Ctr. for Internet & Soc'y), *available at* http://ssrn.com/abstract=1304190.

19. Michael S. Gazzaniga, *Facts, Fictions, and the Future of Neuroethics*, *in* NEUROETHICS: DEFINING THE ISSUES IN THEORY, PRACTICE, & POLICY 141, 141 (Judy Illes ed., 2006).

- Because all behavior emerges from the brain, the individual brain, in isolation, is the most relevant site for understanding criminal behavior (this presents the problem of levels of explanation);
- Because the brain is composed of specialized regions, criminal behaviors like unlawful violence of all kinds must arise from particular brain regions (this presents the compound problem of reification and localization); and
- Because some people who commit violent crimes have brain disorders, lawbreaking is best understood as the result of disease or as a disease in itself (this is the problem of alterity or "otherizing").

In viewing the criminal law-neuroscience relationship through the lens of history of science, this Article hopes to offer both caveats and a constructive portrait of how neuroscience might inform criminal law discourse on regulating violence without recapitulating these issues.

Part I of this Article, A History of Violence, examines three movements in law and brain science that prefigure and inform current efforts: phrenological studies of criminal behavior in the late eighteenth and early nineteenth centuries, Cesare Lombroso's "scientific" criminology in the late nineteenth and early twentieth centuries, and psychointervention (lobotomy and electrode implantation) arising against the backdrop of social turmoil of the mid-twentieth century. In each of these subsections, I will show how these disparate (although equally ill-fated) attempts to solve the problem of violent crime through then-current brain sciences evolved similarly: each started out with a precommitment to the idea of the brain localization of violence, often based on studies either of extreme human pathology or studies of animals with substantially different evolutionary histories than humans. The scientific and medical proponents of each had an express interest in the social implications of their work and sought to reform or revise criminal law through their work. And, legal scholars and criminal law actors embraced and put into practice regimes based on the work before an ultimate backlash shut them down.

The tragic shortcomings of the work of earlier eras now are dismissed as unfortunate historical curiosities.[20] This Part will contend, however, that past efforts to invent a scientific criminal law based on brain science foundered on many of the same shoals that could undermine current neurolaw efforts; the history of these

20. Brent Garland & Mark S. Frankel, *Considering Convergence: A Policy Dialogue About Behavioral Genetics, Neuroscience, and Law*, 69 LAW & CONTEMP. PROBS. 101, 109 (2006) (calling prior efforts to integrate brain sciences with criminal law through, for example, phrenology and lobotomy, "misguided" because they were based on "immature science").

failures thus provides a highly relevant set of lessons.

Moving from historical to current efforts to ground criminal law in brain science, Part II describes examples of current scholarship on the neurobiology of violence. It presents arguments of influential scholars that there is a deterministic relationship between violent behavior and what they identify as brain dysfunction. Such scholars embrace the view that the "mechanistically determined" brain contains "the essential ingredients of the human condition."[21] This Part also will examine causal claims made from neuroimaging studies through examining an exemplary study on brain differences between pedophiles and typical adults. Because scholarship described in this Part emphasizes the biology of individual brains above other modes of explaining criminality, it emerges from the tradition of reductionism in Western scientific and philosophical thought. A full-scale critique of reductive individualism in legal uses of brain sciences is beyond the scope of this Article. However, this Part will set up the Article's consideration of the "practical, technical, and epistemic concerns"[22] posed by such brain-based reductionism in criminal law.

Part III shows the formidable, perhaps insurmountable, technical and epistemic hurdles to a purely, or primarily, brain-based view of violent crime. Critiquing current claims within legal scholarship about the neurobiology of violence, it demonstrates the major barriers to the causal localizability of violence to specific parts of the brain (particularly, the prefrontal cortex[23] and the amygdala[24]). This Part looks first at the state of knowledge in neuroscience about the localizability of brain function generally, starting with sensory-motor localization. It then presents the major challenges that other neuroscientists have raised in relation to attempts to localize higher cognitive functions and behaviors, like "violence." Finally, it considers an in-principle barrier to reducing violence entirely to brain operations: the role of law in defining what is or is not "violence." Given that the law can and does change what is encompassed within the category of violence, unlawful violent behavior must be understood at least in part as arising relationally

21. Dean Mobbs et al., *Law, Responsibility, and the Brain*, 5 PLOS BIOLOGY 693, 693 (2007).

22. Snead, *supra* note 10, at 1287.

23. The prefrontal cortex comprises the "associational" part of the frontal lobes of the brain. The frontal lobes contain motor and associational areas. The motor areas are involved in the initiation of skilled motor activities; the associational areas are involved in "distinctly human activities [including] planning, memory, problem-solving, [and] social conduct." THOMAS C. PRITCHARD & KEVIN D. ALLOWAY, MEDICAL NEUROSCIENCE 199 (1999). The many functions of the prefrontal cortex are discussed further, *infra* at notes 192–202 and accompanying text.

24. The amygdala is a small structure deep in the brain that is believed to play a role in regulating emotion. PRITCHARD & ALLOWAY, *supra* note 23, at 174.

between people and the law, rather than entirely internally to the brain.

The final Part draws out the conceptual and epistemological commonalities among current and historical criminal law efforts to understand violence neurobiologically. It will argue that past and current efforts to develop a purely brain-based understanding of violence in criminal law manifest certain epistemological problems. While contemporary researchers now use sophisticated techniques to image or stimulate parts of the brain, today's claims that a general cause of violence is overactivity or hypometabolism in certain brain regions are not conceptually distinct from lobotomists' claims that violence could be cured through cutting out the violent part of the brain[25] or phrenologists' assertion that there is a "murder bump."

Moving to the potential uses of neuroscience in the criminal law, Part IV will contrast the legal applications of neuroscience that would emerge from the view that violent conduct is the expression of brain dysfunction versus those that would emerge from a view that the brain is an important, but not exclusive, level of explanation for different types of violent crimes. The former approach is strongly individualistic; its prescriptions would focus on finding and treating some disorder within the offender's brain. The second approach would also account for medical pathology, if any. But, in viewing the brain as a contributor to and a product of the social world, and in viewing violence as a set of behaviors that are not *per se* pathological, this approach points toward using neuroscience as one tool to help understand an array of issues of relevance to the criminal law, including—among other issues—how people make decisions about obeying or breaking the law; what conditions provoke violence in typical as well as atypical people; and the general conditions (such as minimum early childhood needs) for developing healthy, well-functioning minds.

I. A HISTORY OF VIOLENCE (IN CRIMINAL JURISPRUDENCE)

The criminal law takes as its object the definition, deterrence, and punishment of proscribed violent behavior; indeed, the regulation of interpersonal violence (and the arrogation to the state of the prerogative to inflict violence) arguably is a primary focus of criminal lawmaking and theory.[26] So explanations of the causes of—

25. Amygdalotomy is a type of psychosurgery (lobotomy) in which the surgeon excises or destroys the amygdala.

26. *See, e.g.*, DAVID GARLAND, PUNISHMENT AND MODERN SOCIETY: A STUDY IN SOCIAL THEORY 74–81 (1990) (discussing Durkheim's view of the criminal law as institutionalized vengeance); Martha Minow, *Institutions and Emotions: Redressing Mass Violence*, *in* THE PASSIONS OF THE LAW 265, 265 (Susan A. Bandes ed., 1999) ("The institution of criminal justice in liberal societies . . . transfers the authority and power to respond to private violence from the victim

and potential ways to identify and address people prone to—violence are, at least in theory, of great criminal law significance. Accordingly, theories of the causes of violence and of ways to identify and deal with people who may be prone to violence historically have exerted tremendous pull over many criminal law scholars and practitioners. "We are placing the question of violence right in the middle of our basic research on the neurobiology of emotion," says clinical psychologist Richard Davidson.[27]

This Part looks at several examples of historical efforts to tackle violence scientifically within law: phrenological studies of criminal behavior in the early nineteenth century, Cesare Lombroso's "scientific" criminology in the late nineteenth and early twentieth centuries, and psychosurgery and subsequent, related efforts on the neurobiological control of violence arising in part out of mid-twentieth century United States race riots. This history of these failed scientific approaches to violence in the criminal law highlights general methodological and epistemological traps; it thus provides a highly relevant and instructive set of lessons. The sometimes uncanny similarities between past and current efforts also provide a useful counterbalance to the current untempered enthusiasm for "neurolaw" solutions to problems of violence.

A. The Original Scientific Criminologies

1. Phrenology: You Should Have Your Head Examined[28]

Phrenology was the nineteenth century's science of the mind. Scientists and doctors who practiced phrenology, starting with the Austrian anatomist Franz Josef Gall, contended that a person's character could be determined from the bumps and hollows on the outside of the skull.[29] From the beginning, Gall's work intersected with the criminal law, as he principally developed his observations and theories through examining the heads of criminals and those

. . . to the state[.]"); James Q. Whitman, *Between Self-Defense and Vengeance / Between Social Contract and Monopoly of Violence*, 39 TULSA L. REV. 901, 922–23 (2004) (discussing "the monopoly of violence theory" as a compelling "account of the purposes of criminal law").

27. Brian Mattmiller, *Brain Study Sheds Light on Impulsive Violence*, U. WIS.-MADISON NEWS, July 27, 2000, *available at* http://www.news.wisc.edu/5121 (interview with Richard Davidson).

28. AMERICAN HERITAGE DICTIONARY OF IDIOMS 239 (1997) (the expression to "get one's head examined" is "thought [to] allude to . . . phrenology"; probable origin in "[e]arly 1900s").

29. MADELINE B. STERN, HEADS AND HEADLINES: THE PHRENOLOGICAL FOWLERS X–XI (1971) (describing Gall's role in originating the science of phrenology); *see also* JOHN D. DAVIES, PHRENOLOGY FAD AND SCIENCE: A 19TH-CENTURY AMERICAN CRUSADE 5–7 (1955) (describing phrenology); Pierre Schlag, *Law and Phrenology*, 110 HARV. L. REV. 877, 879–81 (1997) (describing Gall's method).

confined for insanity.[30] Specific bumps and depressions were said to correspond to qualities like "wit," "joking," and "poetic ability."[31] Others corresponded more closely to the study of violent crime: an "instinct to kill,"[32] "combativeness," and "destructiveness."[33] All was not lost, though, if your skull revealed you to be, for example, hopelessly humorless (or murderous): you could increase the size of your brain's funny bone, as it were, through the right sorts of exercise, changing both your character, your brain, and (presumably) the shape of your skull.

Fashionable citizens flocked to phrenologists to have their "heads examined"—with decidedly mixed results. Samuel L. Clemens (better known as Mark Twain) visited a prominent phrenologist in 1873, under another assumed name.[34] The good doctor discovered something remarkable about his anonymous patient: a "total absence of the sense of humor."[35] Three months later, the same phrenologist was delighted to welcome a very famous new patient: Mark Twain. During the examination of *Mr. Twain*, the phrenologist discovered a "'Mount Everest . . . [of] a bump of humor.'"[36]

Twain's experience with phrenology was innocent fun, but phrenology had serious impacts on the criminal law in the United States and Europe. Phrenology informed criminal law reform proposals,[37] jurists used phrenology to separate the criminal from the insane and to provide reliable ways to identify both;[38] expert phrenological testimony was introduced at sentencing as a

30. Letter from Dr. F.J. Gall to Joseph Fr. de Retzer, Upon the Functions of the Brain, In Man and Animals, *reprinted in* DAVID GEO GOYDER, MY BATTLE FOR LIFE: THE AUTOBIOGRAPHY OF A PHRENOLOGIST 143–52 (1857); *see also* Donald Simpson, *Phrenology and the Neurosciences: Contributions of F.J. Gall and J.G. Spurzheim*, 75 ANZ J. SURGERY 475, 476 (2005) (noting that Gall regularly "palpated the heads of … criminals; wherever possible, he obtained their skulls. His skull collection benefited from his association with the deputy chief of police . . . who presumably had his own ways of obtaining the heads of criminals"); Kenneth J. Weiss, *Isaac Ray's Affair with Phrenology*, 34 J. PSYCH. & L. 455, 460 (2006) (describing Gall's development of his theories through his work with criminal offenders); John Van Wyhe, *The Authority of Human Nature: The Schädellehre of Franz Joseph Gall*, 35 BRIT. J. HIST. SCI. 17, 22 (2002) (discussing Gall's work in prisons and with criminals to develop and perfect his cranial measurements and trait localizations).

31. Simpson, *supra* note 30, at 476 (reproducing list of traits).

32. *Id.*

33. THOMAS SEWALL, AN EXAMINATION OF PHRENOLOGY 18, 20 (1837) (discussing phrenology critically; noting that phrenologists generally claimed "impulsive" murderers had unusually pronounced faculties of combativeness).

34. MARK TWAIN, THE AUTOBIOGRAPHY OF MARK TWAIN 64–66 (Charles Neider ed., 1959).

35. *Id.* (quoting the phrenological doctor).

36. *Id.* (internal punctuation omitted).

37. Stacey A. Tovino, *Imaging Body Structure and Mapping Brain Function: A Historical Approach*, 33 AM. J.L. & MED. 193, 205 (2007).

38. *See* discussion *infra* notes 44–47 and accompanying text.

mitigating factor;[39] and the founder of forensic psychiatry embraced phrenology as a way of showing the trier of fact the relationship between brain and behavior.[40]

"Prophylactic" phrenology was proposed to determine who might be a risk for criminal behavior in the future.[41] Indeed,

> police departments even claimed to put this theory into practice, training their detectives to arrest "criminal types"—who had not to their knowledge committed any crime—on sight. "Keen observers have over and over again marked and arrested apparently inoffensive rogues, whom they had never seen before in person or in pictures."[42]

Phrenology also influenced the M'Naughten test for insanity; that test's separation of the ability to know right from wrong from the rest of the accused's state of mental disease reflects the phrenological notion of distinct mental "organs," in significant contrast to other, more integrative views of mind and mental disorder.[43]

Judges turned to phrenology to determine the sanity of murderers (and for many civil uses, as well, such as ascertaining the capacity of testators and witnesses).[44] In *Farrer v. State*, for example, an 1853 murder case, the Ohio Supreme Court turned to phrenology in considering whether a housekeeper could be held criminally responsible for poisoning a young boy.[45] The judge wrote that the housekeeper was "remarkably ugly."[46] All but diagnosing her from the bench, the judge noted that a phrenologist would just have to look at the shape of her head to know she was criminally

39. Weiss, *supra* note 30, at 476.

40. Kenneth J. Weiss, *Isaac Ray at 200: Phrenology and Expert Testimony*, 35 J. AM. ACAD. PSYCH. & L. 339, 344 (2007).

41. Weiss, *supra* note 30, at 465 (describing the development of skull collections for research purposes to help develop preventative identification programs); *see also* Nicole Rafter, *The Murderous Dutch Fiddler: Criminology, History, and the Problem of Phrenology*, 9 THEORETICAL CRIMINOLOGY 65, 75 (2005).

42. SIMON A. COLE, SUSPECT IDENTITIES: A HISTORY OF FINGERPRINTING AND CRIMINAL IDENTIFICATION 24 (2001) (quoting the work of Boston Superintendent of Police, BENJAMIN P. ELDRIDGE, OUR RIVAL THE RASCAL: A FAITHFUL PORTRAYAL OF THE CONFLICT BETWEEN THE CRIMINALS OF THIS AGE AND THE DEFENDERS OF SOCIETY–THE POLICE (1897)).

43. United States v. Freeman, 357 F.2d 606, 615–18 (2d Cir. 1966) (providing history of the M'Naghten test and discussing the influence of phrenology on the development of the same).

44. Tovino, *supra* note 37, at 201–02.

45. 2 Ohio St. 54, 60–61 (1853); *see also* Tovino, *supra* note 37, at 202 (discussing the *Farrer* case).

46. *Farrer*, 2 Ohio St. at 60 (remarking that such a shape of the skull was "unfavorable to the usual presumption of sound mind and full capacity").

insane, with murderous impulses.[47]

Another judge, in an 1840 civil case concerning the capacity of a testator, spoke for the pervasive influence of phrenology on legal culture when he stated that:

> [N]o man having any regard for his reputation in medical science, would dispute that the brain . . . consist[s] of distinct organs, each having a distinct function, and that power of function is influenced by organic size.[48]

Yet, by the mid-1900s, phrenology, this "true science of the mind" that had influenced criminal laws, criminal and civil trials, and the course of peoples' lives, had the status of a joke. Not only was phrenology discarded as a tool of justice—much less the path to "Reform The World . . . [and] Perfect our Republic,"[49]—it was banned in many U.S. jurisdictions alongside "fortune telling" and astrology.[50] In recent jurisprudence, phrenology has been classed with "voodoo."[51]

This spectacular fall from grace came in the normal way: scientists challenged phrenology internally to science, while social theories about the nature of the mind—particularly with the advent of Freudian psychoanalysis in the early twentieth century—challenged it externally, ultimately resulting in an integrative paradigm of mind with no place for fixed "brain organs." As early as 1838, neuroanatomists had shown that the brain did not have enough discrete regions to support the claim that all major personality traits could arise from specialized brain organs.[52] Many showed, as well, that the various parts of the brain need to work in concert to produce most types of actions.[53] Furthermore, it became clear—over much social contestation, particularly about race and sex—that brain size (and the size of parts of the brain) bore no clear

47. *Id.*

48. Brock v. Luckett's Executors, 5 Miss. 459 (1840); *see also* Tovino, *supra* note 37, at 202 (discussing the *Brock* case).

49. Tovino, *supra* note 37, at 205 (quoting *The American Phrenological Journal for 1849*, 11 PHRENOLOGICAL J. 12 (1849)).

50. Tovino, *supra* note 37, at 203.

51. United States v. Gipson, 24 M.J. 246, 249 (C.M.A. 1987) (describing the hierarchy of scientific evidence and stating that "[a]t the bottom lies a junk pile . . . so universally discredited that a trial judge may safely decline even to consider [its contents], as a matter of law. To that level have been relegated such enterprises as phrenology, astrology, and voodoo").

52. SEWALL, *supra* note 33, at 38–39 (criticizing phrenology for its nonfalsifiability and noting that "[n]either the cortical or the fibrous part of the brain reveals, upon dissection, any of those compartments or organs, upon the existence of which the main fabric of phrenology is based").

53. WALTHER RIESE, A HISTORY OF NEUROLOGY 96 (1959) (describing the work of nineteenth-century French neurologist Pierre Flourens on the integrated functions of the brain).

relationship to aptitude,[54] and that people could retain particular traits or abilities when the part of the brain in which the trait allegedly resided was destroyed by illness or injury.[55]

If phrenology's approach to the relationship between brain structure and character sounds unscientific, or even silly, pause: it is very close in certain respects to modern approaches. Phrenologists identified the biology of particular parts of the brain as the most relevant explanation for character and behavior—a person is a killer or a humorist based on his brain's configuration. This makes the individual brain the most (perhaps the sole) relevant consideration in determining whether a person has a criminal nature. Furthermore, it turns actions that people do into statuses of what they are; a person who engages in a violent criminal act does so because he *is* a biological criminal, someone physically different from law-abiding people.

Although phrenology ultimately failed as a science, and lives as the pseudoscience *par excellence* in the public and judicial imagination,[56] "it left behind a formalized concept of cerebral localization" of complex behaviors and of root biological difference between law-breaking and law-abiding people.[57] This way of thinking about brain structure and its relationship to criminality left the door open to the notion that "a science not too different from . . . phrenology . . . could be used" to investigate putative biological difference between people who commit criminal acts and others.[58] That legacy soon would be picked up by a young doctor whose zeitgeist included phrenology, Cesare Lombroso.

2. Lombrosian Biological Criminology

Shortly after the demise of phrenology, "biological criminology" (or "criminal anthropology")[59] sprang from the brain of a criminal. When Cesare Lombroso was a young doctor at the asylum in Pavia, he was asked to conduct a postmortem on an infamous serial rapist and murderer. Opening the criminal's skull to reveal his brain, Dr. Lombroso had an insight "like a flash of light."[60]

54. STEPHEN JAY GOULD, THE MISMEASURE OF MAN 105–42 (1981).

55. SEWALL, *supra* note 33, at 58.

56. *See Gipson*, 24 M.J. at 249.

57. Tovino, *supra* note 37, at 207 (citing WILLIAM R. UTTAL, THE NEW PHRENOLOGY: THE LIMITS OF LOCALIZING COGNITIVE PROCESSES IN THE BRAIN 20 (2001)); *see also* SCOTT A. HUETTEL ET AL., FUNCTIONAL MAGNETIC RESONANCE IMAGING 2 (2004); STERN, *supra* note 29, at 34.

58. Tovino, *supra* note 37, at 207.

59. For a history of this movement, see DAVID G. HORN, THE CRIMINAL BODY: LOMBROSO AND THE ANATOMY OF DEVIANCE (2003) (providing an excellent general history both of Lombroso's work and of the development and influence of the school of criminal anthropology).

60. Cesare Lombroso, *Introduction* to GINA LOMBROSO FERRERO, CRIMINAL MAN: ACCORDING TO THE CLASSIFICATION OF CESARE LOMBROSO xiv–xv (1911), *excerpted in* BIOLOGY, CRIME & ETHICS 37, 38 (Frank H. Marsh & Janet Katz

He claimed to have found numerous abnormal features of the brain (as well as the skull), including an enlargement of the cerebellum[61] "like that found in the lower types of apes, rodents, and birds."[62] In this moment, from this brain, Lombroso formed his famous theory of atavistic criminality—that is, that criminality results from a person having a throw-back brain to something lower than the "primitive savages": indeed, back to the "carnivor[es]."[63] Although biological criminology later embraced other "atavistic" features of born criminals that linked them to the "primitive races" (such as longer forearms and, absurdly, "the prehensile foot"),[64] it is the head of the criminal—the house of the criminal mind—that gave rise to the biological criminology movement.

In her well-known treatise *Criminal Man*, Gina Lombroso Ferrero (Cesare's daughter) wrote of the biological differences between criminal and noncriminal individuals, emphasizing differences in the head and "psychic [mental] and sensitive [nervous system] functions . . . "[65] Leaving no doubt about her view of the origins of these differences, she entitled her central chapter "The Born Criminal."[66] In it, she writes that the "Modern, or Positive, School of Penal Jurisprudence" maintains that people become criminals as a result of their atavistic "psychic organisation," which "differs essentially from that of normal individuals"; indeed, criminals' brain structure and nervous systems "strongly resemble primitive races."[67]

Lombroso's claims that criminals have atavistic brains sparked a craze for brain dissection.[68] Generally, the results of these

eds., 1985); *see also* MARY GIBSON, BORN TO CRIME: CESARE LOMBROSO AND THE ORIGINS OF BIOLOGICAL CRIMINOLOGY 20 (2002).

61. The cerebellum is a structure at the base of the brain involved in basic voluntary motion, such as the unconscious regulation of gait and motion, and the integration of sensory information to facilitate motion. PRITCHARD & ALLOWAY, *supra* note 23, at 332.

62. LOMBROSO FERRERO, *supra* note 60, at 6.

63. *Id.* at 7.

64. *Id.* at 5, 7–8. Note that the features Lombroso and his followers identified as atavistic characteristics of criminals were not, in fact, found upon physical examination of criminals. In their desire to see criminals as akin to the lower "carnivores," Lombroso and others asserted that born criminals had long, fierce canine teeth and "cheek pouches," in addition to the prehensile foot. *Id.* at 7; *see also* GOULD, *supra* note 54, at 127 (discussing forearm ratios); *id.* at 129 (discussing the prehensile foot).

65. LOMBROSO FERRERO, *supra* note 60, at 5.

66. *Id.* at iii.

67. *Id.* at 5.

68. *See generally* Robert Fletcher, President, Anthropological Soc'y of Washington, Address before the Anthropological Society of Washington (Apr. 21, 1891), *in* 4 AM. ANTHROPOLOGIST 201, July 1891, at 201–36 (summarizing brain dissection work of noted anthropological criminologists and describing the results). For a general introduction to Lombroso's work, see, for example, CESARE LOMBROSO, CRIME: ITS CAUSES AND REMEDIES (Henry P. Horton ed. &

dissections proved disappointing: they did not confirm any systematic differences in the gross anatomy of violent criminals' brains relative to those not convicted of criminal offenses.[69] But Lombroso and his followers were not dissuaded by these facts: while they acknowledged that the abnormalities Lombroso described in his first specimen were not present in "other degenerates," different brain abnormalities nevertheless were "prevalent in criminals."[70] The absence of any consistent correlations between structural brain defects and criminality seemed to reflect only that the brain is "a very recalcitrant organ [that] gives us an infinite deal of trouble when we attempt to establish positive relations between its substance and the operations of the faculties of the mind . . . ."[71]

The failure of brain dissection to confirm systematic differences between criminals and noncriminals tempered some claims by Lombrosians. However, they did not retreat from claims about brain differences related to violence. Gina Lombroso Ferrero acknowledged that "lesser criminals" may not possess atavistic brains; yet, those who commit "peculiarly monstrous" crimes, like murder, nearly always demonstrate the "atavistic" brains of animals.[72] There is no evidence that the brain dissections of this era did produce findings of structural brain differences between perpetrators of violent crimes versus nonviolent crimes (or of noncriminals); yet, the insistence on physical differences violent criminals' brains seemed particularly "sticky," difficult to dislodge in light of countervailing evidence.

Lombrosian biological criminology reveals fascinating parallels to contemporary claims about the neurological bases of violent crime. Today's assertion that "crime [is] a disease"[73] flowing from disordered "neurobiology" echos the claims of early twentieth century biological criminologists like L. Hamilton McCormick, who asserted, "[c]rime is . . . pathological"; it is "pathological, as it is owing to morbid affections of the brain that men frequently adopt crime as a profession."[74] Placed side-by-side without citations, a reader would have difficulty distinguishing the Lombrosian statement from the new neurolaw statement—one claims that

trans., 1911); *see also* Marvin Wolfgang, *Cesare Lombroso, 1835-1909*, *in* PIONEERS IN CRIMINOLOGY 232, 246–57 (Hermann Mannheim ed., 2d ed. 1972) (describing Lombroso's work on the putative physical abnormalities of convicted criminals).

69. Fletcher, *supra* note 68, at 219.

70. LOMBROSO FERRERO, *supra* note 60, at 6.

71. *Id.* at 22.

72. *Id.* at 7–8 (quoting VICTOR HUGO, *The Last Days of a Condemned*, *in* THE DEATH PENALTY: A LITERARY AND HISTORICAL APPROACH 103, 105 (Edward G. McGehee & William H. Hildebrand eds., 1964).

73. Kirchmeier, *supra* note 4, at 631.

74. L. HAMILTON MCCORMICK, CHARACTEROLOGY: AN EXACT SCIENCE 560 (1920).

"crime [is] a disease" and the other that "crime is . . . pathological"; one says it flows from "neurobiology," and one says it flows from the "brain." The current view is that violence emerges from disorders of the prefrontal cortex, which is said to regulate executive function and judgment; the nineteenth century criminal anthropologists claimed a relationship to deficits in the "the antero-superior district of the brain," roughly equivalent to the prefrontal cortex, "which betokens morality and trustworthiness . . . ."[75]

If the ghosts of Lombroso were those of mere bad science—faulty data or superseded hypotheses—we could look back but fleetingly at the specter. But it signifies more. Lombroso is a synecdoche for the hope that a biological criminology is possible, that the laws of man can yield to the laws of science. A contemporary critic of biological criminology (or "criminal anthropology") spoke to its shortcomings in language that could apply equally to the neurolaw of today, saying that the field:

> [O]ccupies the debatable ground between science and philosophy. As a science, it is positive and aggressive. As a philosophy, it consists almost wholly of negations, the chief of which are the negation of spirit, of freedom of the will, and of moral responsibility.[76]

B. Listless Monkeys and Raging Bulls: Twentieth Century Psychointervention

1. Psychointervention's Promise to Cure Violence

While biological criminology fell into disrepute, like phrenology before it, it nevertheless helped spawn the next set of tragic errors in the relationship between criminal law and brain science: direct brain interventions against the putative neurobiology of violence. In the tumultuous middle of the twentieth century, it seemed that "[h]uman violence [was] the most threatening problem in our world . . . ."[77] But the so-called violence problem, fortunately, appeared "solvable"—through the miracles of psychosurgery (lobotomy)[78] and

75. *Id.* at 562.

76. FREDERICK HOWARD WINES, PUNISHMENT AND REFORMATION: AN HISTORICAL SKETCH OF THE RISE OF THE PENITENTIARY SYSTEM 254 (1895).

77. VERNON H. MARK & FRANK R. ERVIN, VIOLENCE AND THE BRAIN 1 (1970).

78. There are several terms for surgical interventions in the brain aimed at modifying behavior. While the term "lobotomy" has the greatest common currency, it actually refers to one specific type of brain surgery, excision or destruction of a portion of the brain's frontal lobes—hence, "lobe-otomy." Other terms for brain surgeries aimed at changing mood or behavior (rather than correcting a medical pathology) include psychiatric neurosurgery, mental surgery, functional neurosurgery, sedative neurosurgery, and psychosurgery. *See* Stephan L. Chorover, *The Pacification of the Brain*, PSYCHOL. TODAY, May 1974, at 59, 59. This type of surgery is not "directed at treating specific kinds of neuropathology (e.g., tumors and strokes) or disorders of movement (e.g.,

electrode implantation.[79] This enthusiasm for psychointervention carried forward beliefs about the brain as the best level on which to address criminality, the localization of violence to specific parts of the brain, and about the biological differences between people who do and do not commit violent crimes.

These continuities between mid-century psychointervention and prior criminal law-brain science movements are not only thematic but actually historical. Psychosurgery's earliest founder, Gottleib Burckhardt, drew his inspiration directly from the claims of innate brain difference advanced by Lombrosian criminology and phrenology. Reasoning that "[o]ur psychological existence is composed of single elements, which are localized in separate areas of the brain," Burckhardt believed that he could literally "extirpat[e]" unwanted behaviors by removing specific portions of the brain.[80]

In 1891, Burckhardt tested this idea by removing the cerebral cortices[81] of six people confined in his asylum in Prefargier, Switzerland.[82] His results were poor (one patient died and five remained at least as psychotic) and so it was not until nearly fifty years later that psychosurgery took off—following the chance encounter of a Portuguese politician and some apathetic monkeys.[83]

In 1935, Antonio Egas Moniz, a retired Portuguese ambassador with training in neuroscience, attended the International Congress of Neurology in Boston.[84] There, two American researchers, John Fulton and Carlyle Jacobsen, presented their results on lesions in the frontal lobes and/or amygdalae of monkeys and chimpanzees: these primates ordinarily were hostile to researchers but, after bilateral lesions to their frontal lobes, were "strikingly indifferent to stimuli that preoperatively provoked responses of extreme agitation and frustration."[85] They showed drastic behavioral changes, including deficits in learning and memory, but also were listless or

tremors and paralysis)." *Id.* I use "psychosurgery" throughout because it is the common term in the scientific and medical literature, and it encompasses a broader range of behavioral-focused neurosurgeries than the more limited term "lobotomy."

79. MARK & ERVIN, *supra* note 77, at 1 (calling the violence problem "solvable" and advocating psychosurgery and other brain interventions).

80. Stephan L. Chorover, *Psychosurgery: A Neuropsychological Perspective*, 54 B.U. L. REV. 231, 232–33 (1974) (quoting E. Valenstein, BRAIN CONTROL (1974) (urging his colleagues to "tread the path of cortical extirpation")).

81. The cerebral cortex is the outer layer of the brain, with all the characteristic convolutions and folds. It is believed to be an evolutionarily later development and the site of many of "higher," or distinctively human, brain functions.

82. Chorover, *supra* note 80, at 232–33. This is the first instance of psychosurgery reported in any western medical journal. *Id.* It is beyond the scope of this Article to address brain surgeries performed by other cultures such as, for example, trepanning by ancient American civilizations.

83. *Id.* at 233.

84. *Id.*

85. *Id.*

tame.[86] Moniz asked the presenters if similar surgery could "relieve anxiety states" in people.[87]

Fulton and Jacobsen were shocked at Moniz's suggestion, but Moniz put his idea into action immediately. On his return to Portugal, Moniz and a colleague performed twenty surgeries in a ten-week period on human subjects in which they destroyed portions of the patients' frontal lobes.[88] Touting his successes, Moniz claimed that these people were miraculously "cured," and that those "who had previously been violent . . . became calm, tractable, and generally easier to manage."[89] Lobotomy as a treatment for violence, cloaked in a heavy degree of (possibly self-deluding) misrepresentation about its safety and efficacy, was born.

Moniz's purported successes with frontal lobe surgery (hence "lobe-otomy") led him to be awarded the Nobel Prize in 1949.[90] And, it led to tens of thousands of psychosurgeries in the United States and around the world. In the United States alone, about 70,000 people were subjects of lobotomy between the 1940s and mid-1960s.[91]

The fascination with brain-based causes of and potential "cures" for violence pervaded brain sciences in the mid-century. Animal studies, particularly with monkeys, rats, and one very famous bull, seemed to point the way toward controlling man's more animal nature. Proselytizers for the criminal law applications of "sedative psychosurgery," as they called it, Vernon Mark and Frank Ervin drew heavily on the same kind of monkey studies that first inspired

86. *Id.*

87. *Id.*

88. *Id.* at 234. Moniz's original technique consisted of injecting alcohol and wax into portions of the brain, causing brain tissue to coagulate and die. Later, he refined his technique into what he termed the "leucotomy," using a specially-designed cutting instrument, the leucotome, to remove portions of brain tissue. Later techniques were both more and less crude. *Id.* Walter Freeman notoriously pioneered the "ice pick" lobotomy, a simple procedure in which an ice pick-like device was driven through the orbits of the skull and into the frontal lobes; given its simplicity, it was performed in a near-assembly line fashion. An innovation of greater sophistication was stereotactic neurosurgery, which, using three-dimensional maps of the brain and highly specialized surgical equipment, allowed for precise surgeries anywhere in the brain, including in its deeper structures like the amygdala. STANLEY FINGER, ORIGINS OF NEUROSCIENCE: A HISTORY OF EXPLORATIONS INTO BRAIN FUNCTION 292–94 (1994).

89. Chorover, *supra* note 80, at 234.

90. JEROME KAGAN, AN ARGUMENT FOR MIND 52–53 (2006).

91. *See Hearing on S. 974, S. 878, and S.J. Res. 71 Before the Subcomm. on Health of the Senate Comm. on Labor and Public Welfare*, 93d Cong. 340 (1973) (noting that about 50,000 Americans received lobotomies between the 1940s and mid-1950s); *see also* ELLIOT S. VALENSTEIN, BRAIN CONTROL: A CRITICAL EXAMINATION OF BRAIN STIMULATION AND PSYCHOSURGERY 58 (1974) (stating that approximately 4,000 psychosurgeries per year were performed on U.S. patients from 1960 through about 1964).

Moniz. Mark and Ervin noted that "after both temporal lobes have been removed," monkeys are "placid, can be easily handled, and do not respond aggressively even to attack . . . ."[92] They also seem without anxiety, putting objects in their mouths "that ordinarily provoke fear, such as small snakes."[93] Showing even more dramatic examples of subduing primal violence, "[l]ocalized removal of the amygdala will tame a predatory and vicious lynx or a wolverine."[94] Analogizing people who have committed criminal violence to the "lynx or . . . wolverine," they note that, "[i]ndeed, neurosurgeons have surgically removed areas of the amygdala to treat assaultive behavior in patients . . . ."[95]

Around the same time, "an alternate form of psychosurgery"[96]—electrical stimulation of parts of the brain—also promised a solution to the "violence problem." Throughout the 1950s and 1960s, the criminal law and scientific communities together explored electrical brain stimulation as a method to "effectively wipe out violence" in society.[97] The majority of this work consisted of electrical stimulation of parts of animals' brains to evoke or suppress what the researchers characterized as violent behavior or inappropriate sexual behavior. In perhaps the most dramatic piece of theater a scientist ever staged, Dr. Jose Delgado of Yale University organized a bullfight—a special bullfight designed to show the triumph of neuroscience over animal aggression. Delgado arranged a "'brave bull,' a variety bred to respond with a raging charge when it sees any human being."[98] Delgado implanted an electrode in the caudate nucleus of the bull's brain and, before a packed audience of scientists, media, and others, Delgado stopped the charging bull by activating the electrode—the power of science stopping animal aggression in its tracks.[99]

92. MARK & ERVIN, *supra* note 77, at 28.

93. *Id.*

94. *Id.* at 29. Sampling here just some of the work summarized and relied upon by Mark and Ervin, *id.* at 38–46; B.N. Brunnell et al., *Septal Lesions and Aggressiveness in the Cotton Rat, Sigmodon Hispidus*, 6 PSYCHONEUROLOGICAL SCI. 443 (1966); C.E. Davis, *The Physiological Analysis of Aggressive Behavior*, *in* SOCIAL BEHAVIOR AND ORGANIZATION AMONG VERTEBRATES 53 (W. Etkin ed., 1964); M.D. Egger & J.P. Flynn, *Effects of Electrical Stimulation of the Amygdala on Hypothamically Elicited Attack Behavior in Cats*, 26 J. NEUROPHYSIOLOGY 705 (1963); H. Ursin & B. Kaada, *Functional Localization within the Amygdaloid Complex in the Cat*, 12 EEG CLIN. NEUROPHYSIOL. 1 (1960); L. Weiskrantz, *Behavioral Changes Associated with Ablation of the Amygdaloid Complex in Monkeys*, 49 J. COMP. PHYSIOL. PSYCHOL. 381 (1956).

95. MARK & ERVIN, *supra* note 77, at 29.

96. Lauren Slater, *Who Holds the Clicker? Neuroscientists Hope that Brain Implants Can Treat Intractable Mental Illness*, MOTHER JONES, 2005 WLNR 17886179 (Nov. 1, 2005).

97. *Id.*

98. Boyce Rensberger, *Can a Pill Be Mightier Than the Sword?*, N.Y TIMES, Sept. 12, 1971, at E9.

99. *Id*.

Delgado's work seemed to hold tremendous and direct promise for law enforcement. Recruited by government agencies, Delgado worked for many years (although fruitlessly) on a brain-computer interface and on brain stimulation techniques to control human violence.[100]

2. Psychointervention and Criminal Law Initiatives

While psychointervention, like phrenology and biological criminology, started out in asylums, it, too, soon made inroads into criminal law through its participation in the discourse on violence.[101] Indeed, if psychosurgery could fix the brain "dysfunction" causing violent conduct among the mentally ill, why stop at the asylum gates? Psychointervention might quell civil unrest (associated with the mid-century struggle for civil rights) and all kinds of other criminal violence.[102] Particularly, psychosurgery might "treat" urban rioters, leaders of civil unrest (i.e., those involved in the civil rights movement), and violent prisoners of all kinds.[103] As the heralds of this transition of psychosurgery from a psychiatric treatment to an all-purpose social curative wrote, psychointervention offers "a new and biologically oriented approach to the problem of human violence."[104]

Under the view of mind and behavior that animated psychointervention, violence can only arise from brain disorder—because with a "well-ordered brain," a person "need never be out of control."[105] If a person does go "out of control," then there are only two possible reasons: "either the limbic system [which includes the amygdala] has become pathologically hyperactive" or "its neocortical [frontal lobe—executive function] (control) inputs have become abnormal."[106] In their landmark book *Violence and the Brain*, Professors Mark and Ervin of Harvard and MIT argued that such "brain malfunction" causes "a low threshold for impulsive violence" and that people convicted of a crime involving violence likely suffer from such brain disease.[107]

100. *Morning Edition: Neuroscientists Gather in Washington to Discuss Cutting-Edge Research and Cautionary Reflections on Stem Cell Research* (NPR radio broadcast May 20, 2005), *available at* 2005 WLNR 25360638 (noting that Delgado's goal was to develop technologies such that governments could use brain stimulation to control people's behavior).

101. *See* Chorover, *supra* note 80, at 232–33.

102. Vernon H. Mark et al., Letter to the Editor, *Role of Brain Disease in Riots and Urban Violence*, 201 J. AM. MED. ASS'N 217, 217 (1967) (arguing that urban race riots were born not of rage at oppression or poverty but of physiological "dysfunction" in the rioters); *see also* MARK & ERVIN, *supra* note 77, at 1.

103. *See* Chorover, *supra* note 80, at 245.

104. MARK & ERVIN, *supra* note 77, at xi.

105. *Id.* at 32.

106. *Id.* at 32–33.

107. *Id.* at 2.

Deriding views that crime rates reflect levels of policing, or socioeconomic or demographic factors, these researchers asserted that criminal violence is caused and explained exclusively by the perpetrators' disordered neurobiology.[108] Thus, they recommended that people convicted of crimes of violence should have psychosurgery to remove their amygdalae.[109] In this, Mark and Ervin were emblematic of a broader movement in the biological control of violence and particularly of proposals to perform psychosurgery or electrode implantation on prisoners.[110]

While mass lobotomization of urban protesters and prisoners never did take place, a few experiments on prisoners tested out the idea.[111] In 1968, under the auspices of the California Department of Corrections, several prisoners (including one minor) at the Vacaville State Penitentiary in Vacaville, California, underwent surgical implantation of electrodes for the purpose of destroying amygdalar tissue; the goal was to eradicate their desire and ability to engage in violent behavior.[112] The experiment was carried out by a military surgeon from a nearby air force base, and Vacaville used its metalwork shop to craft a special device to hold the prisoners' heads in place for the procedure.[113]

The Vacaville experiment produced poor results: the one prisoner whose surgery the prison authorities deemed successful, and who was paroled, was rearrested for robbery almost immediately after his release.[114] Nevertheless, enthusiasm for solving criminal problems through psychointerventions went on unabated. In 1972, the Neuropsychiatric Institute of the University of California at Los Angeles proposed to develop a Center for the Study and Reduction of Violence, intended to identify violent predispositions and develop brain-based techniques for preventing and treating violent behavior.[115] The Center was to be funded

108. *Id.* at xi (deriding theories that relate rates of violent crimes either to levels of policing or to social and economic factors).

109. *See* ELLIOT S. VALENSTEIN, BRAIN CONTROL: A CRITICAL EXAMINATION OF BRAIN STIMULATION AND PSYCHOSURGERY 253–54 (1973) (discussing the work of Mark and Ervin).

110. For example, in 1970, the International Conference of Psychosurgeons entertained proposals to "initiate pilot programs for precise rehabilitation [through psychosurgery] of the prisoner-patient who is often young and intelligent, yet incapable of controlling various forms of violence." *Id.* at 255 (quoting remarks of Dr. M. Hunter Brown).

111. Robert J. Trotter, *A Clockwork Orange in a California Prison*, SCI. NEWS, Mar. 11, 1972, at 174.

112. *Id.* at 174–75.

113. Leroy F. Aarons, *Brain Surgery Is Tested on 3 California Convicts*, WASH. POST, Feb. 25, 1972, at A1, A20.

114. *Id.* at A20.

115. Dorothy Nelkin & Judith P. Swazey, *Science and Social Control: Controversies Over Research on Violence*, *in* BIOLOGY, CRIME AND ETHICS 344, 346 (Frank H. Marsh & Janet Katz eds., 1985).

primarily by the federal Law Enforcement Assistance Administration ("LEAA").[116] In furtherance of its violence-prevention strategy, the LEAA also extensively funded research into brain implants and other brain intervention techniques.[117]

Ultimately, the once-heralded efforts to address criminal problems through psychosurgery and electrostimulation led lawmakers and neuroscientists alike to call to restrict the procedures, particularly on prisoners and children.[118] Psychointervention is easy to dismiss as horrifying but irrelevant; the technology seems primitive, and there is little risk that similar technologies would be tested on prisoners and incompetents today, given the advent of rigorous Internal Review Boards for human experimentation and heightened ethical awareness.[119]

Yet, psychointervention has immediate lessons now. While we now know that the claims of psychointervention were inflated and we reject its abuses, its logic—like that of phrenology—is both elegant and fully consistent with prior movements in understanding violence entirely internal to the brain: either violent people have disordered thoughts,[120] produced by frontal lobes disorder; or they have abnormal fear and rage reactions, which arise from the amygdala.[121] The investigator then tries to solve what he or she has defined as the *brain*'s violence problem through brain intervention—a seductively simple solution to a multifaceted and complex set of problems. In this, we see a version of the same argument currently advanced in reductionist approaches to neuroscience in criminal law—that dysfunction of the amygdala (or other parts of the brain regulating emotional processing), or of the frontal lobes, is the most prevalent and relevant cause of violent crime.

II. THE NEW CRIMINAL LAW AND NEUROSCIENCE OF VIOLENT CRIME

While many kinds of behaviors might be of legal and social interest,[122] there "is a marked tendency" in neurobiological

116. *Id.*

117. *Id.*

118. *See, e.g.*, S.J. Res. 86, 93d Cong. (1973) (statement of Sen. Beal) (introducing a resolution calling for a two-year moratorium on psychosurgery during which the Secretary of Health, Education, and Welfare would assess available data and make recommendations on the procedures); Chorover, *supra* note 80, at 247 (proposing creation of regulatory agencies at the state and federal level to recognize that psychosurgery is experimental; safeguard prisoners, children, and the mentally retarded; and develop a registry of all psychosurgery procedures to allow follow-up of patients who undergo psychosurgery).

119. Slater, *supra* note 96 (describing review boards and FDA oversight for experimental neurosurgical medical devices and procedures).

120. KAGAN, *supra* note 90, at 52–53.

121. *Id.*

122. BRENT GARLAND, NEUROSCIENCE AND THE LAW: BRAIN, MIND AND THE

discussions of crime "to focus on violent behaviors."[123] Indeed, the "[p]rediction of violence," as well as its control, is a central, shared interest of "science [and] the legal system" and is likely to remain a core area of collaboration between these fields.[124] For this reason, there is "a massive (and growing) body of scientific literature on both the neuroanatomical and neurochemical bases" of violence.[125]

The major criminal law prescriptions that are emerging from this work include challenges to retributive rationales for punishment and to capital punishment.[126] Extending the premises of this work further, that because all human conduct emerges from a determined brain system and our sense of free will and choice are purely illusory, criminal law should proceed on consequentialist grounds only, with punishment being replaced by a system of medically-tailored rehabilitation.[127]

While this is intended to be humane, it is worth keeping in mind Paul Robinson's argument that "the harshness of the current system may be attributed in largest part to the move to rehabilitation, incapacitation, and deterrence, which *disconnected criminal punishment from the constraint of just desert*."[128]

SCALES OF JUSTICE: A SUMMARY REPORT ON AN INVITATIONAL MEETING CONVENED BY THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE AND THE DANA FOUNDATION 9 (2004).

123. Owen D. Jones, *Behavioral Genetics and Crime, in Context*, 69 LAW & CONTEMP. PROBS. 81, 90 (2006).

124. GARLAND, *supra* note 122, at 9 (containing a section entitled "Predicting Violence," when no other section of the report expressly was dedicated to predicting any other type of behavior).

125. Snead, *supra* note 10, at 1293–94 (citations omitted). Professor Snead has conducted an admirable literature review of the recent neuroimaging work on violence and aggression. *See id.* at 1298–99 (citing Antoine Bechara et al., *Insensitivity to Future Consequences Following Damage to Human Prefrontal Cortex*, 50 COGNITION 7, 8 (1994) (demonstrating connection between prefrontal lobe damage and impaired decisionmaking through neuropsychological testing); R. James R. Blair, Editorial, *Neurobiological Basis of Psychopathy*, 182 BRIT. J. PSYCHIATRY 5 (2003) (discussing neuroimaging studies finding association between amygdala dysfunction and psychopathy and noting probable impairment of orbitofrontal cortex in psychopathic individuals); R. James R. Blair, *Neurocognitive Models of Aggression, the Antisocial Personality Disorders, and Psychopathy*, 71 J. NEUROLOGY NEUROSURGERY & PSYCHIATRY 727 (2001) (discussing neurocognitive models of aggression and relating them to explanations of antisocial personality disorder); Antonio R. Damasio, *A Neural Basis for Sociopathy*, 57 ARCHIVES GEN. PSYCHIATRY 128, 128–29 (2000) (noting that the observed reduction in prefrontal white matter volume in psychopaths supports the view that sociopathy is "related to the malfunction of . . . critical components in the prefrontal cortex"); Kent A. Kiehl et al., *Limbic Abnormalities in Affective Processing by Criminal Psychopaths as Revealed by Functional Magnetic Resonance Imaging*, 50 BIOL. PSYCHIATRY 677 (2001) (examining correlation between affective processing anomalies in criminal psychopaths and deficient input from limbic structures)).

126. Snead, *supra* note 10, at 1269–70.

127. *Id.* at 1270.

128. Paul H. Robinson, *The A.L.I.'s Proposed Distributive Principle of*

A. Does Violent Crime Arise from Prefrontal Cortex and Amygdalar Dysfunction?

Members of several fields who currently work on criminal violence assert that criminal violence arises as a result of dysregulation of the prefrontal cortex ("pfc") and the amygdale—indeed, that these parts of the brain "play preeminent roles in [violent] behavior."[129] So far, the "core findings" on violence and the brain are that the amygdala is involved in "fear and other negative emotions," while the orbitofrontal cortex (a portion of the pfc) contributes to "constraining impulsive outbursts[.]"[130] According to proponents of this view, a diverse body of research, including new neuroimaging and older animal studies, supports the notion that violent behavior initiates in the amygdala and that its expression is regulated by the pfc.[131]

"Limiting Retributivism": Does It Mean in Practice Anything Other than Pure Desert?, 7 BUFF. CRIM. L. REV. 3, 14 (2003) (emphasis in original).

129. Christopher M. Filley et al., *Toward an Understanding of Violence: Neurobehavioral Aspects of Unwarranted Physical Aggression: Aspen Neurobehavioral Conference Consensus Statement*, 14 NEUROPSYCHIATRY NEUROPSYCHOLOGY & BEHAV. NEUROLOGY 1, 1 (2001) (discussing conclusions of the Aspen Neurobehavioral Conference's consensus statement on the relationship between mind, brain, and violence); *see also* Snead, *supra* note 10, at 1294.

130. BRUCE H. DOBKIN, THE CLINICAL SCIENCE OF NEUROLOGIC REHABILITATION 61 (2003) (quoting Richard Davidson et al., *Dysfunction in the Neural Circuitry of Emotion Regulation—A Possible Prelude to Violence*, 289 SCI. 591, 591–94 (2000)).

131. *See* Snead, *supra* note 10, at 1294–95 & nn.146, 148 & 150 (reviewing research on the relationship between amygdala and pfc function, and violent behavior). For some of the most significant work in this area, see M.C. Brower & B.H. Price, *Neuropsychiatry of Frontal Lobe Dysfunction in Violent and Criminal Behaviour: A Critical Review*, 71 J. NEUROLOGY NEUROSURGERY & PSYCHIATRY 720, 722–23 (2001) (surveying eighteen neuroimaging or neuropsychological studies touching on frontal lobe dysfunction and violent behavior); Richard L. Frierson & Ryan D. Finkenbine, *Psychiatric and Neurological Characteristics of Murder Defendants Referred for Pretrial Evaluation*, 49 J. FORENSIC SCI. 604, 605 (2004) (discussing studies observing frontal lobe dysfunction in murderers); Adrian Raine et al., *Prefrontal Glucose Deficits in Murderers Lacking Psychosocial Deprivation*, 11 NEUROPSYCHIATRY NEUROPSYCHOLOGY & BEHAV. NEUROLOGY 1, 2 (1998) (examining whether "prefrontal dysfunction may specifically characterize violent offenders who lack psychosocial deficits"); Adrian Raine et al., *Reduced Prefrontal and Increased Subcortical Brain Functioning Assessed Using Positron Emission Tomography in Predatory and Affective Murderers*, 16 BEHAV. SCI. & L. 319, 321 (1998) [hereinafter Raine, *Reduced*] (assessing "differences between affective and predatory murderers in cortical and subcortical brain functioning"); Adrian Raine et al., *Brain Abnormalities in Murderers Indicated by Positron Emission Tomography*, 42 BIOLOGY PSYCHIATRY 495 (1997); Adrian Raine et al., *Selective Reductions in Prefrontal Glucose Metabolism in Murderers*, 36 BIOLOGY PSYCHIATRY 365, 365–66, 370–71 (1994) [hereinafter Raine, *Selective*]. In 2005, Jana L. Bufkin and Vickie R. Luttrell reviewed seventeen neuroimaging studies of aggressive, violent, and antisocial psychiatric patients, and concluded that

Impressive, even astounding, statistics support the claim that frontal lobe or pfc dysfunction is the major cause of all kinds of violent crime. Professor Richard Redding, citing Dr. Adrian Raine's studies of incarcerated criminals, contends that "the prevalence rate [*sic*] of brain dysfunction . . . [is] *ninety-four percent* among homicide offenders, [and] sixty-one percent among habitually aggressive adults . . . ."[132] By contrast, the claimed "prevalence rate [of brain dysfunction] in the general population is only *three percent*."[133]

While some more cautious legal scholars and neuroscience researchers note that the causal relationship between the degree of frontal lobe activity and any specific conduct is at best unestablished,[134] others leap forward: we are asked to believe that "neuroscience research . . . provides *compelling explanatory evidence*" that frontal lobe dysfunction plays "a *causal* role" in most types of violent crime.[135] Following this view, understanding pfc and amygdalar dysfunction should provide the foundation for future "criminology, crime prevention efforts, and the functioning of the criminal justice system."[136]

B. Claims that Particular Crimes Arise from Specific Neural Patterns—A Biological Basis for Terrorism?

Related to the claims that dysfunction in two key brain regions are involved in violent crime, some scholars contend that particular types of neural activation patterns within these and related regions give rise to specific violent crimes. Future work, it is claimed, may

prefrontal dysfunction is "consistently related to aggressive and/or violent behavior[.]" Jana L. Bufkin & Vickie R. Luttrell, *Neuroimaging Studies of Aggressive and Violent Behavior*, 6 TRAUMA VIOLENCE & ABUSE 176, 182 (2005).

132. Redding, *supra* note 3, at 57 (emphasis added) (citing Nathaniel J. Pallone & James J. Hennessy, *Brain Dysfunction and Criminal Violence*, 35 SOC'Y 21, 21 (1998)). Note that Pallone and Hennessy used a particularly expansive definition of brain dysfunction.

133. *Id.* (emphasis added) (citing Richard E. Redding, *Why It Is Essential to Teach About Mental Health Issues in Criminal Law (And a Primer on How To Do It)*, 14 WASH. U. J.L. & POL'Y 407, 408–10 (2004) (reviewing data on the prevalence of mental disorders among adults who come into contact with the criminal justice system)).

134. *See, e.g.*, Jedediah Purdy, *The Promise (and Limits) of Neuroeconomics*, 58 ALA. L. REV. 1, 3 (2006) (noting that "[e]ven at its most sophisticated, brain imaging can only give us a map of correlations, which are physical events in the brain that correspond to the activity of the mind"); *id.* at 14 (describing some neuroeconomics studies based on neuroimaging as "flirt[ing] with the emptiness of mere correlation").

135. Redding, *supra* note 3, at 57–58 (emphasis added); *see also, e.g.*, Raine, *Reduced*, *supra* note 131, at 327–28; Adrian Raine, *Selective*, *supra* note 131 at 365–66 (finding lower than average glucose metabolism in the lateral and medial prefrontal cortex of murderers who agreed to be tested; hypothesizing decreased activity in these brain regions may be predictive of one's propensity to violence).

136. Bufkin & Luttrell, *supra* note 131, at 176.

establish the biological basis for all types of human violence, including "[a]cts of ethnic cleansing, school shootings, bombings, hostage takings, [and] incidents of terrorism . . . ."[137] It is suggested that there may be a unique "neural topograph[y]" for every crime ranging from "sadistic murder[ ]" to "political terroris[m]."[138] This understanding, in turn, "will contribute to [the] detection, control, and alleviation" of violent crime, in part through predicting a person's "level of dangerousness, and risk of recidivism . . . ."[139]

Additionally, with such an understanding of the causes (or at least markers) of particular crimes, lawmakers may be able to approach different types of criminal violence based on the (putatively) distinct neurobiology of each.[140]

What is the basis for these claims? Research on the neurobiology of bombers themselves is extremely limited (and necessarily excludes subjects who might be of the greatest interest, successful suicide bombers).[141] The most comprehensive study of school shooters, issued in 2000 by the FBI, focused on behavioral warning signs; it did not investigate school shooters on the neurobiological level.[142] To date, no studies have been conducted on neurobiology and terrorism[143] or neurobiology and ethnic or political violence. Rather, these claims that specific crimes arise from specific brain dysfunction grow out of two important but indirect strands of research: decades of experiments on aggression in animals, and a few recent human studies using functional magnetic resonance imaging ("fMRI").[144]

137. Joseph E. McEllistrem, *Affective and Predatory Violence: A Bimodal Classification System of Human Aggression and Violence*, 10 AGGRESSION & VIOLENT BEHAV. 1, 22 (2004).

138. Mobbs et al., *supra* note 21, at 695.

139. McEllistrem, *supra* note 137, at 22–23.

140. Mobbs et al., *supra* note 21, at 695.

141. McEllistrem, *supra* note 137, at 21 (noting research on bombers is "limited," speculating on characteristics of bombers based on the study of bomb-disposal experts and summarizing the existing research).

142. FEDERAL BUREAU OF INVESTIGATION, CRITICAL INCIDENT RESPONSE GROUP, THE SCHOOL SHOOTER: A THREAT ASSESSMENT PERSPECTIVE 1 (2000), http://www.fbi.gov/publications/school/school2.pdf (reviewing school shootings and developing a four-prong threat assessment matrix).

143. Judy Skatssoon, *In the Mind of a Terrorist*, ABC HEALTH & MED.NEWS Aug. 21, 2006, http://www.abc.net.au/science/news/health/HealthRepublish_1720057.htm (quoting Susan Greenfield, Director, Oxford Centre for Science of the Mind) (stating that no studies have been conducted on the neurobiology of terrorist behavior).

144. For a synopsis of how brain images are made and interpreted, see, for example, Laurence R. Tancredi & Jonathan D. Brodie, *The Brain and Behavior: Limitations in the Legal Use of Functional Magnetic Resonance Imaging*, 33 AM. J.L. & MED. 271, 272–76 (2007) (describing the mechanics of EEG, PET, and fMRI image production and interpretation in a section entitled "Basics of Brain Imaging"). For a discussion of the "limitations and distortions" of fMRI, see *id.* at 278–80 (noting that, among other difficulties, brain images can "vary significantly both between subjects and across sessions [with the same

Animal models of aggression have provided the basis for research on human violence for about a century. In these studies, cats and rats display different patterns of brain activation depending on whether they were provoked to display "defensive rage" or "predatory aggression."[145] (In ordinary English, "defensive rage" and "predatory aggression" in cats and rats translate roughly to "guarding territory from other cats or rats" and "preying on rats or mice.") Violence researchers have extrapolated from these distinct patterns of aggression in animals that people, similarly, may have different neurological bases for what they call "hot" violence—crimes of sudden rage, like heat of passion crimes—and "cold" crimes of premeditation, like the proverbial cold-blooded killing.[146]

In one recent article, *Law, Responsibility, and the Brain*, the authors argue that a universal brain circuitry may underlie people's "defensive" violent acts (like justified self-defense, as well as inappropriate violent responses to what a similarly situated reasonable person would not perceive as a threat) versus their "predatory" aggressive acts, like an act of revenge, a crime for financial gain, or other premeditated violent crimes.[147] Extrapolating further from the general categories of defensive and predatory aggression in cats and rats, the authors propose that distinct "neural topographies" may underlie specific types of crimes, ranging from "sadistic murder[ ]" to "political terroris[m]."[148]

On one level, these types of claims that distinct patterns of neural activation underlie different behaviors must be true: insofar as there is a materialist basis for all human thought and action, there likely are distinct neurobiological correlates for thinking of or engaging in any X versus any Y—say, liking or not liking a particular restaurant.[149] That proposition is likely to be uncontroversial, but also merely trivially true; it tells us nothing about *causation*—about the relationship between observed neural

subject]").

145. McEllistrem, *supra* note 137, at 3–4.

146. *Id.* at 14–16. For articles distinguishing between "hot" and "cold" crimes based on models of animal aggression, among many see, for example, Leonard Berkowitz, *Is Something Missing? Some Observations Prompted by the Cognitive—Neoassociationist View of Anger and Emotional Aggression*, *in* AGGRESSIVE BEHAVIOR: CURRENT PERSPECTIVES 35, 35–37 (L. Rowell Huesmann ed., 1994).

147. Mobbs et al., *supra* note 21, at 695 (representing a collaboration between specialists in neuroimaging and legal scholars).

148. *Id.* It is unclear which of these crimes is supposed to be "hot" or "cold," as high affect like rage, as well as premeditation, could be present in both.

149. *See* Elizabeth A. Phelps & Laura A. Thomas, *Race, Behavior, and the Brain: The Role of Neuroimaging in Understanding Complex Social Behaviors*, 24 POL. PSYCHOL. 747, 754–55 (2003) (using the example of how experience with a restaurant would be encoded into one's brain, but that that has little follow-on significance for).

activation patterns, why those patterns are present, and how they relate to why people do the things they do.[150]

The claim that a distinct "neural topography" might underlie "sadistic murder" or "political terrorism" is a much larger claim than the trivial truth claim above: this claim is not that brain activation patterns reflect and enable everything that people do (and that, on average, very similar patterns will underlie the same actions across neurotypical people). Instead, it is the claim that people engage in particular crimes *because of* specific, disordered neurobiology. At a minimum, under this view, the brain of a political terrorist would function differently from that of a sexual sadist; at the most, a person would become a terrorist or sexual sadist *because* he possessed a certain functional or structural neurobiological predisposition or defect. The authors expressly embrace this more radical claim, stating that while "[a]t first glance, such reasoning looks like phrenological folly," nevertheless "studies strongly suggest that some kinds of criminal behaviour are associated with dysfunction of different regions of the brain."[151]

Only if the case is the latter is it meaningful to propose that lawmakers ought to approach crimes based on their distinct neurobiology—or that the criminal law finally could realize the Lombrosian dream of a biological criminology.[152] Thus, this view of the neurobiology of violence, like its forbearers in other criminal law and neuroscience movements, posits that disordered brains are the most relevant site at which to understand the cause of violent crimes, and that many people who commit crimes of violence do so as a result of neurobiological dysfunction.

A recent and striking example of this type of imaging study is Professor Martin Walter's *Pedophilia Is Linked to Reduced Activation in Hypothalamus and Lateral Prefrontal Cortex During Visual Erotic Stimulation*.[153] Walter's study is the first to use fMRI to compare the neurological responses of self-described pedophiles and self-described normal adults to erotic material featuring adults.[154] The researchers scanned the subjects' brains while the subjects looked at adult pornography. The fMRIs of pedophiles

150. As Professors Phelps and Thomas, preeminent researchers on amygdalar function and behavior, note, "[a]lthough it is often exciting to demonstrate a neural basis for a given behavior, it should not be surprising to show that *any* behavior has an identifiable neural substrate." *Id*. at 754 (emphasis in original).

151. Mobbs et al., *supra* note 21, at 695.

152. Note that Professor Redding, who suggests that biological criminology could be realized through this type of work (see Redding, *supra* note 3), is not one of the authors of the article *Law, Violence, and the Brain*, *supra* note 21. The connection between these claims is that of the author of this Article.

153. Martin Walter et al., *Pedophilia Is Linked to Reduced Activation in Hypothalamus and Lateral Prefrontal Cortex During Visual Erotic Stimulation*, 62 BIOLOGICAL PSYCHIATRY 698 (2007).

154. *Id.* at 698.

during the experiment showed reduced activation of the hypothalamus and prefrontal cortex "as compared to healthy individuals when they were viewing sexually arousing pictures of adults."[155] The study's authors suggest that pedophilia may arise from a defective neurological activation pattern (too little activity in the hypothalamus).[156]

Brain imaging studies ultimately may contribute to understanding the origins and treatment of pedophilia. But an imaging study like this one has less explanatory power than it at first might seem, and little relevance for criminal law regimes aimed at pedophiles. Essentially, the researchers here correlated sexual arousal with activity in certain parts of the brain. This in itself is an interesting result that helps confirm the role of certain parts of the brain in arousal, but it does not reveal much, if anything, about the causes of pedophilia—or whether people who do or do not show such an activation pattern ever will abuse a child.

The results of this study would be expected by anyone who subscribes to a materialist view of consciousness—that is, that all our thoughts and emotions have some physical, detectable reality. Subjects who said they were attracted to adults showed activity in structures associated with arousal when they looked at erotic pictures of adults. The subjects who said in advance of the scanning that they were *not* attracted to adults did not show the same degree of activity in the those areas. This study thus neatly demonstrates that people show arousal when they see what turns them on and that they don't when they don't.[157] This fits the materialist model perfectly but does not support taking the leap to claims about the causes of pedophilia or even, apart from causation, whether such scans could be used to predict behavior in, e.g., decisions about the release of an incarcerated pedophile.

Relatedly, this pedophilia study shows the degree to which scans may not reveal brain pathology *per se* but simply neural correlates of thoughts and behaviors that may be harmful, antisocial, or illegal. If another experiment were run in which normal adults failed to show brain arousal in response to *child* pornographic images, one might see the same lack of hypothalamic activation and concomitant absence of inhibitory pfc activity. Yet, we would not define that as evidence of a brain dysfunction or speak

155. Rick Nauert, *Brain Imaging of Sexual Predators*, PSYCHCENTRAL, http://psychcentral.com/news/2007/09/24/brain-imaging-of-sexual-predators/1325.html (last visited Mar. 4, 2008).

156. Walter et al., *supra* note 153, at 699–70.

157. It is unclear why there would be any expectation that a group of subjects would have any response (neurological or otherwise) to an erotic category in which they have no interest. A group of shoe fetishists might show arousal in response to a patent leather stiletto but not to a handbag; handbags are the wrong fetish object. But one could not make the shoe fetishist a handbag fetishist just by juicing up the degree of activity in the hypothalamus.

of hypothalamic "deficits" in the subjects; for good reasons, we do not consider lack of sexual attraction to children to be pathological.

Defining activation or lack of activation in particular parts of the brain as "disorder" or "dysfunction" necessarily must start from a normative position about the thing that is being described. And so these definitions of biological dysfunction based on correlating brain activation patterns with legally proscribed conduct have an element of circularity. When we do this, we are reasoning from conclusions about abnormality and back-fitting them into scanner patterns. But we as yet have no basis on which to conclude that the activation pattern causally produces the proscribed thing or represents a medical pathology.

C. Tales of the Good Man Gone Bad—Brain Injury as Catalyst to Crime

Finally, scholars who contend that violence should be understood as a disease of localized brain dysfunction often point to one-off cases of outlandish injury or unusual disease to try to show that violence arises from disinhibition of the prefrontal cortex or dysfunction in the amygdala. In these case histories, damage to these areas causes previously law-abiding folk to transmogrify into impulsive, violent criminals—by extension, they support the implication that brain dysfunction is a major cause of criminal violence, making the individual brain the right level at which to explore and address such criminality.

The paradigmatic story of the relationship between frontal lobe dysfunction and violence, repeated in nearly all legal and popular science literature on the subject (and now to be repeated here), is that of Phineas Gage.[158] Phineas Gage was a law-abiding railway worker who, in 1848, suffered a bizarre industrial accident: an explosive charge meant to drive an iron tamping rod into the ground backfired—and drove the rod through Gage's cheek-bone, behind his

158. *See* WILLIAM R. UTTAL, THE NEW PHRENOLOGY: THE LIMITS OF LOCALIZING COGNITIVE PROCESSES IN THE BRAIN 165 n.4 (calling the Gage story a "mainstay of pop psychology"). Among many sources repeating the Gage story, see, for example, Joseph H. Baskin et al., *Is a Picture Worth a Thousand Words? Neuroimaging in the Courtroom*, 33 AM. J.L. & MED. 239, 244 (2007) (describing the Phineas Gage case to show relationship between orbitofrontal damage and violent behavior); Raymond J. Dolan, *On the Neurology of Morals*, 2 NATURE NEUROSCIENCE 927, 927 (1999) (citing J.M. Harlow, *Passage of an Iron Rod Through the Head*, 39 BOSTON MED. & SURGICAL J. 389 (1848)) (discussing Gage's treatment by his physician, Harlow); Redding, *supra* note 3, at 70–72 (discussing Gage case as exemplary of the relationship between orbitofrontal damage and violence); Peggy Sasso, *Implementing the Death Penalty: The Moral Implications of Recent Advances in Neuropsychology*, 29 CARDOZO L. REV. 765, 792–94 (2007) (devoting a section of the article to the Gage case; describing it as the seminal case on the relationship between damage to the prefrontal cortex and violent and/or sexual disinhibition of conduct).

eye socket, and out the top of his head.[159]

In addition to the direct trauma to his skull and brain, he also suffered major hemorrhaging and a brain abscess.[160] Amazingly, Gage's injuries healed and he lived another thirteen years. Yet, he went through a marked change: he became ill-tempered and obstreperous.[161] For the rest of his life, Gage suffered a variety of deficits and frequently was in minor trouble with the law.[162]

The modern paradigmatic story linking violent criminality to brain disorder is the tragic story of Charles Whitman, an Eagle Scout, scholarship student at the University of Texas, and by all accounts loving husband and son, who murdered his wife, mother, and fourteen students at the University of Texas on August 1, 1966.[163] Whitman began to experience headaches and personality changes about a year before his attacks; he believed that he was suffering from a neurological problem and sought medical and law-enforcement help (including asking the police to arrest him earlier in the day that he committed his murders; the police were obliged to decline because Whitman had not yet committed any crime).[164] A post-mortem shortly after Whitman was shot by police showed a large tumor compressing Whitman's amygdaloid nucleus.[165]

A few recent cases follow a similar pattern: a socially respectable man—a teacher, a stock broker—suffers a brain injury and morphs into a perpetrator of violence or sex crimes.[166] When the brain injury heals (or the tumor is removed), the man returns to his gentle and law-abiding ways.

While neuroscientists caution against reading too much into such stories,[167] less cautious criminal law and neuroscience

159. Hanna Damasio et al., *The Return of Phineas Gage: Clues About the Brain from the Skull of a Famous Patient*, 264 SCI. 1102, 1102–05 (1994).

160. *See* Randolph W. Evans, *Brain Injury*, 285 J. AM. MED. ASSOC. 215, 215 (2001) (reviewing MALCOLM MACMILLAN, AN ODD KIND OF FAME: STORIES OF PHINEAS GAGE (2000)).

161. Damasio et al., *supra* note 159, at 1102.

162. *Id.*

163. *See* GOVERNOR'S COMM. & CONSULTANTS, REPORT TO THE GOVERNOR: CHARLES J. WHITMAN CATASTROPHE, MEDICAL ASPECTS (1966).

164. *Id*.

165. *Id*.

166. *See, e.g.*, Jeffrey M. Burns & Russell H. Swerdlow, *Right Orbitofrontal Tumor with Pedophilia Symptoms and Constructional Apraxia Signs*, 60 ARCHIVES OF NEUROLOGY 437, 437–38 (2003) (describing case of forty-year old man who engaged in uncharacteristic, unlawful sexual behavior incident to developing tumor in the orbitofrontal cortex and whose behavior returned to normal after removal of tumor); Becky Sheaves, *The Freak Accident that Left My Son Obsessed with Sex*, DAILY MAIL, July 4, 2006, at 49 (describing the case of Andrew Laing, who, incident to a concussive injury to the frontal lobe, became physically and sexually aggressive).

167. VOLAVKA, *supra* note 1, at 78 (describing factors making such cases difficult to extrapolate from, including: the multiple brain areas affected by the accident or lesion, the lack of control subjects, and, most significantly, sampling

scholarship makes a direct connection between Gage's accident and Whitman's tumor to violent crime in general. The work *Charles Whitman: The Amygdala and Mass Murder* typifies the genre.[168] The Gage and Whitman cases figured prominently in the recent symposium on neuroscience and the criminal law at Baylor University's center on Law, Brains, and Behavior. In the opening remarks of the conference, Dr. David Eagleman argued that the Whitman and Gage cases have important implications for criminal notions of culpability and provide the groundwork for understanding criminal violence as a medical problem arising from brain disorder.[169] Similarly, major criminology textbooks use Whitman's tumor as the starting point for a general explanation of violent crime as arising from brain dysfunction.[170]

The role that these case histories play in the literature is to show that criminal violence is a pathology—that it can be produced by brain trauma and alleviated by brain correction.[171] The view presented by this handful of brain trauma cases is that the most relevant level at which to understand the general phenomenon of criminal violence is internal to the individual—at the level of his or her neurobiology or neurochemistry—and, specifically, can be localized to the prefrontal cortex or amygdala. Finally, they present the claim that the violent person is fundamentally "Other," essentially not-us, because he or she has a different (literally sick) brain. Thus, in these cases, we see all three of the major tenets of brain-behavior reductionism that historically have been manifest in past episodes of brain sciences in the criminal law.

bias—people with brain injuries who become violent come to the attention of law enforcement and violence researchers, whereas people with brain injuries who are not so affected do not).

168. *See* RHAWN JOSEPH, *Charles Whitman: The Amygdala and Mass Murder*, *in* NEUROPSYCHIATRY, NEUROPSYCHOLOGY, AND CLINICAL NEUROSCIENCE (2d ed. 1996), *available at* http://brainmind.com/Case5.html, *cited in* GENNARO F. VITO ET AL., CRIMINOLOGY: THEORY, RESEARCH, AND POLICY 109 (2d ed. 2007). Professor Joseph also treats the relationship between Whitman's case, the amygdalar complex, and aggression in RHAWN JOSEPH, NEUROPSYCHOLOGY, NEUROPSYCHIATRY, & BEHAVIORAL NEUROLOGY 102–03 (1990), a standard introductory neuroscience text book.

169. David M. Eagleman, Dir., Baylor Coll. of Medicine Initiative on Law, Brains and Behavior, Introductory Remarks to Conference on Neuroscience and Law at Baylor College of Medicine (May 23, 2008), *available at* http://neuro.bcm.edu/eagleman/neurolaw/NeuLawConferencePacket.pdf.

170. *See, e.g.*, MARK M. LANIER & STUART HENRY, ESSENTIAL CRIMINOLOGY 101–02 (2004) (using Whitman story to introduce the concept of "biogovernance" and prediction of violent crime); LARRY J. SIEGEL, CRIMINOLOGY 103 (2005) (connecting Whitman's tumor to the "minimal brain dysfunction" explanation of violent criminality); VITO ET AL., *supra* note 168, at 95–96.

171. Burns & Swerdlow, *supra* note 166, at 437–38.

III. METHODOLOGICAL ISSUES WITH CURRENT LAW AND THE NEUROSCIENCE OF VIOLENCE

Bringing together anecdote and image, stories about the localization of violence in the brain are almost irresistible. They apparently have the most current and sexy science behind them, as well as decades of animal and human trauma research. Yet, there is "an enormous chasm" between what it is scientifically legitimate to say about "the localization problem" and what has "been concluded from well-intentioned, but inadequately reasoned research . . . ."[172] While it may not at first seem legitimate to lump the law and neuroscience of the new millennium with the science of lumps from the 1800s, this Part will show that infirmities continue to dog efforts to equate criminal violence with localized brain dysfunction—and that, for reasons inherent to the ways in which localization questions are posed, and the legal (not biological) content of definitions of criminal violence, likely will continue to do so.

To evaluate the claims that criminal violence is the result of brain dysfunction, this Part first will examine the current state of research on the localization of basic and higher brain processes. Starting with sensory-motor functions, it will show that, even for these relatively simple functions, the localization enterprise runs into problems. It then examines the state of research concerning the localizability of violence to the amygdala and prefrontal cortex, and some efforts to localize violence that have relied on celebrated brain injury cases, like Phineas Gage and Charles Whitman.

As a final, formal barrier to localizing violence in the brain, this Part will suggest that "violence," may be better understood as a legal term and a psychological construct than a biological thing. Legal institutions are essential to defining violence, as shown by the ways that legal definitions of what conduct constitutes violence change across place and time. Even outside of the legal domain, the concept of violence may have no specific biological reality; rather, it may be understood as a psychological construct—a term like "intelligence" or "attachment" that covers a range of mental activities and outward behaviors.

Each of these issues that present a barrier to the straightforward localization of violence could be the subject of a book; while it is beyond this Article to address each of these issues comprehensively, this Part sketches them to inform the legal reader of the active controversies surrounding the study of brain function and violence. Furthermore, each of these questions goes back to the touchstone issues introduced in the beginning of this Article: whether the individual brain (or isolated parts of the brain) is the most relevant level at which to examine problems of criminal violence; whether it is possible to localize a heterogeneous set of

172. UTTAL, *supra* note 158, at 6.

behaviors called "violence" to dysfunction in parts of the brain; and whether people who engage in criminal violence may be biologically different from people who do not.

A. What We Know About Localization Generally

Theories of the localization of complex psychological phenomena, like violence, start from the premise that the brain is made up of specialized modules with distinct functions. Yet, the localization of even very basic brain functions is not as precise as generally is depicted in literature advocating for the localizable nature of violence. Even sensory and motor components of the brain are not neatly divided by function; this calls into question the soundness of hypothesizing that violence is discretely localized.

The brain is clearly not an undifferentiated mass: it is composed of various regions, which are visibly different both in their gross anatomy and cell structure (cytoarchitecture).[173] Sensory and motor functions, in particular, occupy relatively specialized regions of the brain.[174] Some functional differences among these different regions are well-established: the brain stem regulates the most basic functions of the body's survival, such as breathing; the motor cortex, as the name implies, relates to motion and locomotion; specific parts of the brain also are involved in processing and interpreting sensory input such as visual images, smell, and sound. Some areas involved in uniquely human faculties, like speech, also have been identified: Broca and Wernicke's regions, for example, play important (although not exclusive) roles in producing speech, and lesions in these areas can cause different kinds of aphasias.[175] Neuroscientists consider these sensory and motor functions to be the most easily localized to particular regions of the brain.

However, even for these "simple" brain functions, many parts of the brain are involved—and it is not yet known what their contributions are or how they relate to each other. Indeed, it appears that no one part of the brain is sufficient, in isolation, to accomplish any function of a living being.[176] Furthermore, individual variation in brain structure is enormous—particularly among human beings—meaning that the locations in the brain that are involved in one process in one person will not be identical in another person.

Three beautiful and careful examples of neuroscience research on sensory and motor systems—specifically, the auditory, visual, and motor systems—illustrate the difficulties with localizing even these more basic brain functions.

173. *Id.* at 11.
174. *Id.*
175. MARK F. BEAR ET AL., NEUROSCIENCE: EXPLORING THE BRAIN 621–25 (3d ed. 2006).
176. KAGAN, *supra* note 90, at 215.

Processing sound, a basic sensory operation, involves several, known regions of the brain. Yet, putting those components together into "hearing" is not localized in any one part of the brain or even in one general region. If a person is surprised by the sound of a whistle, fMRI imaging shows that twenty-four distinct areas in the brain become active.[177] Prior to imaging studies, neuroscientists would have assumed that many of these areas were not implicated in sound processing at all.[178] Some of the regions may be associated with surprise, sound-identification, and memory. (What does a whistle mean to me?) Thus, a brain scan showing these twenty-four areas lit up would not translate directly to any specific conclusion. No conclusion can be drawn from such a scan about the necessity or sufficiency of any of these regions to processing sound generally or to the identification of a whistle specifically. Nor would it be possible to read backward from the scan either that the person heard a whistle or what a whistle noise means to him or her. That multiple sites are activated in response to a simple auditory task suggests that scientists and legal scholars "cannot assume that a brain site is necessary for a psychological process just because it was active during the process."[179]

This issue with sound processing represents the more general problem of "necessary but not sufficient." Although "it is clearly true that we can say of particular brain regions that they are *necessary* for given behaviors (or their expression)," decades of experiments show that "there is no region of the human brain [including the amygdala or pfc] of which we can say that it is *sufficient* for such functions."[180]

The visual system presents greater complexity and demonstrates a distinct problem. Neuroscientists working on how the brain processes visual stimuli to create "seeing" have made tremendous progress. Going back to the early 1990s, neuroscientists have been able to discern and describe a series of feedback and feed-forward systems between brain "modules" that contribute to the overall gestalt of "seeing."[181] These "modules" have been organized by researchers into a hierarchical model that purports to show the contributions that each one makes to seeing.[182] And yet even here, there may not be the degree of functional localization previously assumed.

Because of the "basic properties of interconnected networks," it appears likely that "complex systems like [the visual system] cannot

177. *Id.*
178. *Id.*
179. *Id.*
180. RICHARD C. LEWONTIN ET AL., NOT IN OUR GENES: BIOLOGY, IDEOLOGY, AND HUMAN NATURE 145–46 (1984) (emphasis in original).
181. UTTAL, *supra* note 158, at 162 (emphasis in original) (citing Hilgetag et al. (1996)).
182. *Id.*

be organized into a unique hierarchical organizational chart."[183] According to systems biologists, who work on the mathematics of complex, nonlinear systems, there is "an *in principle* barrier to the specification of a network hierarchy" like the brain processes that interrelate to create "seeing," "*no matter how many experiments may be carried out.*"[184] While scans of auditory activity raise the necessary/sufficient/incidental problem, the current understanding of the visual system raises the issue that, in a complex networked system, it may be *formally* (that is, mathematically) impossible to determine the independent contributions of different components.

Work in the motor system highlights a third challenge to localization individuality; the unique make-up of every person. Cutting-edge experiments in neurorobotics (brain-robot interfaces) demonstrate that brains are unique in important ways, even as to simple motor functions, like moving one's arm. MacArthur-prize winning neuroroboticist, Yoky Matsuoka, is showing that the motor neurons of every person's brain are organized with important differences that defy precise localization.[185]

Professor Matsuoka's work focuses on designing cybernetic limbs that an amputee can control through thinking about moving the missing limb.[186] To do this, she introduces electrodes into the specific neurons in the subject's brain responsible for activating arm movement.[187] This research would sound as if it supports the localization notion, at least for motor functions. And yet, this is not the case. She explains:

> A person's history determines which neurons control the arm. Even in identical twins, the same neuron in one person could activate the arm, but in the other twin, it could activate the leg. It depends on what the person has touched, seen, done, at critical points in his or her development.[188]

For this reason, it is not possible to identify a general "arm movement location."[189] This is not surprising, because "if our brains were not individual, we could not be individuals."[190]

These problems of localizing sensory-motor functions proliferate as we move to the localization of cognitive functions. Sensory and motor aspects of brain function are anchored to dimensions of time, space, quality (e.g., hot, cold, wet), and intensity; the "further we move from the sensory aspects of cognition . . . the more difficult it

183. *Id.* at 162 (emphasis in original) (citing Hilgetag et al. (1996)).
184. *Id.*
185. Interview with Yoky Matsuoka, Professor, Univ. of Wash., in Santa Barbara, Cal. (Feb. 16, 2007).
186. *Id.*
187. *Id.*
188. *Id.*
189. *Id.*
190. *Id.*

becomes to find particular brain regions exclusively and uniquely associated with a particular cognitive process."[191] Neuroscientists active in localization research concerning higher cognitive functions confront the following problems:

- Cognitive functions activate broadly distributed regions of the brain;
- Brain regions are complexly interconnected;
- Lesion experiments (or accidents) can confirm the involvement but cannot confirm sufficiency of any region to the function under study; and
- Human neuropsychological and experimental data are idiosyncratic.[192]

These are but a few of the issues that "shadow[ed]" efforts to localize complex cognitive functions "with serious and complex conceptual troubles."[193]

B. The Limits of Localizing Violence to the PFC and Amygdala

1. Challenges Posed by Claims About PFC and Amygdalar Function

Legal scholarship advocating for a primarily brain-based understanding of violence hangs substantially on claims about the pfc and the amygdala. Yet, different neuroscientists have come to widely disparate conclusions about the functions of the pfc and the amygdala, implicating them in diverse mental processes unrelated to violence. This lack of consensus should give legal scholars pause before adopting a view about the localization of violence to these parts of the brain.

Looking at research on the pfc first: the prefrontal cortex is without doubt one of the most intricate and sophisticated parts of the brain. Indeed, there is hardly a higher-level cognitive process that one researcher or another has not localized to the frontal lobes. These include, among others:

- general intelligence;[194]
- problem solving;[195]
- executive control;[196]

191. UTTAL, *supra* note 158, at 25.
192. *Id.* at 153. Uttal discusses each of these issues in depth. *Id.* at 153–66.
193. *Id.* at 26.
194. John Duncan, *Attention, Intelligence, and the Frontal Lobes*, *in* THE COGNITIVE NEUROSCIENCES 721, 721 (Michael S. Gazzaniga ed., 1st ed. 1995) [hereinafter COGNITIVE NEUROSCIENCES].
195. ALEKSANDR ROMANOVICH LURIA, HIGHER CORTICAL FUNCTIONS IN MAN 290 (1966).
196. MICHAEL J. POSNER & MARCUS E. RAICHLE, IMAGES OF MIND 32 (1997);

- attention;[197]
- decisionmaking;[198]
- semantic memory;[199]
- perceptual analysis;[200]
- self-awareness; sense of self;[201]
- "the creation and maintenance of explicit relational representations that guide thought and action";[202] and
- "free won't."[203]

This list of functions, which is itself extremely broad, only shows the tip of the proverbial iceberg: a literature review by several neuroscientists of the functions imputed to the pfc produced a seven-page list of different attributions.[204]

The pfc may be involved in all of these activities, and others yet to be determined. If so, what would decreased activation of a person's pfc in a particular situation tell us? The answer is: nothing unambiguously related to the disinhibition of violent conduct. Since activity in the pfc could be related to some, all, or none of the functions above, pfc activity cannot translate directly into impulse control; lower activation does not mean that a person will act on a

Jennifer S. Beer et al., *Frontal Lobe Contributions to Executive Control of Cognitive and Social Behavior*, *in* THE COGNITIVE NEUROSCIENCES 1091, 1091 (Michael Gazzaniga ed., 3d ed. 2004) [hereinafter COGNITIVE NUEROSCIENCES 3D].

197. Glyn W. Humphreys & Dana Samson, *Attention and the Frontal Lobes*, *in* COGNITIVE NEUROSCIENCES 3D, *supra* note 196, at 607, 607.

198. NEUROBIOLOGY OF DECISION MAKING (A.R. Damasio et al. eds. 1996).

199. Anthony D. Wagner et al., *Cognitive Control, Semantic Memory, and Priming: Contributions from Prefrontal Cortex*, *in* COGNITIVE NEUROSCIENCES 3D, *supra* note 196, at 709, 709.

200. Brenda Milner, *Effects of Different Brain Lesions on Card Sorting: The Role of the Frontal Lobes*, 9 ARCHIVES NEUROLOGY 90, 90 (1963).

201. C. Neil Macrae et al., *A Self Less Ordinary: The Medial Prefrontal Cortex and You*, *in* COGNITIVE NEUROSCIENCES 3D, *supra* note 196, at 1067, 1067.

202. Nina Robin & Keith J. Holyoak, *Relational Complexity and the Functions of the Prefrontal Cortex*, *in* COGNITIVE NEUROSCIENCES, *supra* note 194, at 987, 987.

203. GAZZANIGA, *supra* note 11, at 95–96. "Free won't" is what Michael Gazzaniga describes as the ability to stifle inappropriate thoughts, speech, or action. Even if the pfc is the site of "free won't," it is unclear how or where the brain determines what is or is not appropriate under the circumstances. Gazzaniga's localization of "free won't" to the pfc is a wonderful companion to, among others, Renee Descartes' localization of free will to the pineal gland. *See, e.g.*, PETER A. SCHOULS, DESCARTES AND THE ENLIGHTENMENT 169 (1989). In Gazzaniga's schema, however, people are without such a construct as "free will"; rather, our thoughts and actions are totally determined *ex ante* by the structure of our brains. GAZZANIGA, *supra* note 11, at 99.

204. UTTAL, *supra* note 158, at 23–24 (describing and citing J. Grafman, A. Partiot, and C. Hollnagel, *Fables of the Prefrontal Cortex*, 18 BEHAV. & BRAIN SCI. 349 (1995)).

violent urge, and higher activation does not mean that a person will not act on a violent urge.

Similarly, numerous respected brain researchers question the localization of fear to the amygdala,[205] and the leap from fearfulness to violence, because "the amygdala can be activated by many events that have no relation to fear."[206] Pictures of food, the face of an old friend, and couples hugging or kissing, among other images, provoke amygdalar activity as long as the images are unexpected.[207] If a subject thinks he is in an experiment to identify playing cards, and the researcher "shows you a picture of scrambled eggs, your amygdala will light up."[208] This is not because the subject is afraid of or angry about scrambled eggs, but just because the picture is unexpected.[209] This group of researchers believes that "the amygdala gets involved when there's news."[210]

Other prominent contemporary researchers, like Elizabeth Phelps, depict the amygdala's role as mediating between emotion and cognition,[211] and providing a basis for interpreting social information.[212] Still another view is that the amygdala plays a role in visual memory.[213]

The functions of the amygdala could be (and are) the subject of numerous books and scholarly articles. The purpose of this brief discussion is to show the unreliability of claims that draw a linear relationship between amygdalar activity and criminal violence.

205. These include, for example, Eliot Valenstein, William Uttal, Jerome Kagan, and Stephan Chorover. *See* KAGAN, *supra* note 90, at 92 (describing various types of stimuli that lead to activation of the amygdala).

206. *Id.*

207. *Id.*

208. Interview with Stephan L. Chorover, Dep't of Brain & Cognitive Scis., Mass. Inst. of Tech., in (Jan. 29, 2008).

209. *Id*.; *see also* KAGAN, *supra* note 90, at 86–87 ("The brain's first question to every intrusion is: Was this event expected or unexpected? Less than two-tenths of a second later it evaluates the specific meaning of the event and may generate an emotion[al response].").

210. Chorover, *supra* note 208; *see also* KAGAN, *supra* note 90, at 86 (noting that an equal degree of amygdalar activity occurs in response to images of nudes as to angry or fear-provoking images). There could be a relationship between how sensitive a person is to "news" and how fearful he or she is; the two might be related at the level of how easily startled the person might be. A person who is easily startled *might* be excessively fearful, and thus *might* be prone to a greater degree of reactive violence—but that relationship is, on current information, purely hypothetical.

211. Elizabeth A. Phelps, *The Human Amygdala and Awareness: Interactions Between Emotion and Cognition*, *in* COGNITIVE NEUROSCIENCES 3D, *supra* note 196, at 1005, 1005.

212. Ralph Adolphs, *Processing of Emotional and Social Information by the Human Amygdala*, *in* COGNITIVE NEUROSCIENCES 3D, *supra* note 196, at 1017.

213. Stephan L. Chorover, *Violence: A Localizable Problem?*, *in* BIOLOGY, CRIME AND ETHICS 255, 263 (Frank H. Marsh & Janet Katz eds., 1985).

2. Challenges in Correlating Scan Data and Subjective Experience

A final challenge to the relationship between amygdalar or pfc activation and propensity to violence is that substantial discrepancies can exist between activation patterns in an fMRI and what people subjectively self-report about their emotional state. This raises the important question of what to believe—what a scan indicates is going on in a person's head or what the person claims to experience.

Interestingly, some studies find "little or no relation between verbal reports of the intensity of anxiety or fear to pictures of angry or fearful facial expressions and the amount of activity in the amygdala."[214] The same is true when we move from fear or violence to sex: measures of women's physiological response to pornography and their self-reported experience of arousal (or, more typically, lack thereof) correlate poorly.[215]

The divergence between brain scan data and reported subjective experience raises an important question about detecting and regulating criminal violence. We might credit a woman's self-report that she does not feel turned on by pornography even if biological indicators show activity consistent with arousal—whether because we believe she has no incentive to deceive or because it accords with cultural expectations. But what about differences in self-reporting versus scanning in an offender who is up for parole review? Would we credit his claims not to have violent impulses, even though a brain scan indicates reduced activation in the pfc or greater activation in the limbic system relative to standard ranges?

This is a question with serious implications for some of the proposed uses of fMRI data in criminal adjudications: how, generally, could we assess a discrepancy between an fMRI and self-reported mental state, in light of the fact that there can be authentic discrepancies between feelings and scans, and that both the subject and the interpreter might be influenced by incentives and biases? Given the tendency to credit as objective any data that appears in the form of a picture and that is proffered by socially-respected sources,[216] we well might privilege scans over self-reports—and be

214. *Id.* at 214 (citing T. Furmark et al., *Amygdalar Activity during Emotional Perception and Experience in Subjects with Social Phobia*, 57 BIOLOGICAL PSYCHIATRY 169S (2005); A.E. Guyer et al., *Developmental Differences in Attention Related to Amygdala Response to Emotional Facial Expression*, 57 BIOLOGICAL PSYCHIATRY 8S (2005)); *see also id.* at 208 (describing lack of correspondence between observed brain activity and self-reports of experience).

215. *See, e.g.*, Alessandra H. Rellini et al., *The Relationship Between Women's Subjective and Physiological Sexual Arousal*, 42 PSYCHOPHYSIOLOGY 116, 123 (2005).

216. *See generally* Jennifer L. Mnookin, *Fingerprint Evidence in an Age of*

mistaken in doing so.

3. Challenges of Extrapolating from Animal Models

While researchers have implicated the pfc and amygdala in a huge range of functions distinct from violence, the researchers who advocate for a close violence-amygdala/pfc connection often show empirical support for their claims through animal studies. These animal studies provide what appear to be direct and compelling evidence of the role of the amygdala, in particular, in causing violence. The raging bull and the wild monkeys reduced to tameness through interference with their limbic systems—did they not show an amazing absence of aggression?

In fact not. After initial reports that destruction of the amygdala could render "wild" and "aggressive" animals "tame," further experiments showed that the animals likely were suffering from a disruption to their visual memory. So, it was not the case that the animals were without fear, but that they failed to recognize what they were looking at.[217] Thus, their normal fearful or aggressive reaction disappeared because of interference with contextual thinking, not because the amygdala is the storehouse of fearful or aggressive impulses. Indeed, these animals still acted with equal "aggressiveness" to threatening physical stimuli, like being prodded.[218] Their "violent" responses to unpleasant touch but apparent tameness toward everything else makes perfect sense as an unintended consequence of disruption to visual memory: if you do not know what a snake is, you might pick it up and be curious about it. But if it bit you, you'd still throw it down—a "violent" reaction.

Beyond problems with experimental design that could permit conflation of loss of visual recognition or partial paralysis with loss of aggression, the use of animal models in studying human violence, although productive and important, presents certain problems. As discussed in Section III.B, most research on the relationship between the amygdala and animal aggression has been conducted on cats and rats. These experimental animals are cheap, easily available, and share some important basic biology with people. While researchers frequently extrapolate from animal models to human models, brain and behavior are areas where particular care must be taken with transphyletic extrapolation.[219] It is worth remarking on two features cats and rats share, and that humans do

DNA Profiling, 67 BROOK. L. REV. 13 (2001) (discussing judicial and public acceptance of fingerprinting); Jennifer L. Mnookin, *Scripting Expertise: The History of Handwriting Identification Evidence and the Judicial Construction of Reliability*, 87 VA. L. REV. 1723, 1727–29 (2001) (discussing judicial reception of handwriting identification as a form of scientific evidence).

217. Chorover, *supra* note 213, at 263.

218. *Id.*

219. *See, e.g.*, T.C. Schneirla, *Behavioral Development and Comparative Psychology*, 41 Q. REV. BIOLOGY 283, 285 (1966).

not. First, cats and rats are territorial. Second, and also unlike humans, they normally attack mice. Cats and rats have evolved brain systems that enable them to be territorial and to attack certain prey; the amygdala may play some role in these stereotypical cat and rat behaviors that it does not play in the human being.[220]

Evolution is conservative—that is, it does not proliferate new structures for new purposes but generally recruits existing structures to new purposes.[221] In mammalian species, much brain anatomy is the same and yet the functions facilitated by the same brain structures differ between different genuses. This has been shown to be true of the amygdala. Lesions to the amygdala disrupt social communication in some primates, but not in humans.[222] Conversely, lesions near certain language processing areas cause people to have serious social deficits, but, in other primates, "social communication . . . is unaffected."[223] If such differences in amygdalar function exist between people and our closest primate relatives, it is reasonable to ask whether the differences might not be even greater between people and cats or rats.

Extrapolating freely from these experiments, though, in which cats and rats are quicker to attack an intruder if their amygdalae are stimulated and slower or indifferent if their amygdalae are excised, researchers claim that the amygdala plays an important role in human "defensive rage." They hypothesize that a person who is often violent—who, for example, commits frequent acts of road rage or domestic violence—has an overactive amygdala that interprets innocuous stimuli as provocative insults. This kind of excessively violent reaction, hypothesized to spring from amygdalar overactivation, is then (rather circularly) claimed to show that violence is a type of brain pathology.

The problems that can flow from very ambitious extrapolations from animal models are evident in the connection of normal aggression in cats with terrorism by people.[224] From the literature on "defensive rage" and "predatory aggression" in cats and rats, some researchers have asserted (as noted in Part II.B) that unique "neural topographies" might underlie specific human crimes—including whether a person becomes a "political terrorist."[225] Even holding aside the problems of cross-species extrapolation, the related problem of meaning is obvious: terrorism is an inherently

220. For a classic statement of this principle, see Steven J. Gould & Richard C. Lewontin, *The Spandrels of San Marco and the Panglossian Paradigm: A Critique of the Adaptationist Programme*, 205 PROC. ROYAL SOC'Y LONDON B 581, 594 (1979) (discussing phyletic and developmental constraints on evolutionary innovation).

221. *Id*.

222. STEVEN E. HYMAN, 7 THE SCIENCE OF MENTAL HEALTH 126–27 (2001).

223. *Id*. at 123.

224. *See supra* notes 144–48 and accompanying text.

225. Mobbs et al., *supra* note 21, at 695.

political concept that has a plethora of definitions and no independent biological reality.[226] There simply is no way to extrapolate from activation patterns in animal brains to conclusions about (putative) biological bases of human terrorism—much less legal prescriptions for intervention in the same.

4. Issues with Extrapolation from Human Brain Injury Cases

If claims about the localization of violence based on animal experiments are suspect, what about evidence directly from human beings? Accidental brain injuries and brain diseases have produced a host of illuminating scientific curiosities that sometimes have led to medical breakthroughs.[227] But the Gage and Whitman stories are

226. The Second Circuit (among other bodies) has concluded that there is no generally-accepted definition of "terrorism":

> We regrettably are no closer . . . to an international consensus on the definition of terrorism or even its proscription; the mere existence of the phrase "state-sponsored terrorism" proves the absence of agreement on basic terms among a large number of States that terrorism violates public international law. Moreover, there continues to be strenuous disagreement among States about what actions do or do not constitute terrorism, nor have we shaken ourselves free of the cliché that "one man's terrorist is another man's freedom fighter."

United States v. Yousef, 327 F.3d 56, 106–07 (2d Cir. 2003); *see also id.* 106–08 nn.41 & 42.

International treaties and domestic laws offer a plethora of conflicting and controversial definitions of "terrorism." For a small sampling, for example, 6 U.S.C. § 444(2)(B) (2006) (defining terrorism by its effect on United States interests); 8 U.S.C. § 1182(a)(3)(B)(ii) (2006) (excluding aliens based on participation in "terrorist activity" involving, *inter alia*, attacks on third parties to influence the policy of any government); 18 U.S.C. § 2331 (2006) (defining terrorism by motive); Arab Convention on the Suppression of Terrorism, Apr. 22, 1998, *reprinted in* INTERNATIONAL INSTRUMENTS RELATED TO THE PREVENTION AND SUPPRESSION OF INTERNATIONAL TERRORISM 152–73 (United Nations 2001); European Convention on the Suppression of Terrorism, Nov. 10, 1976, Europ. T.S. 90; Declaration on Principles of International Law Concerning Friendly Relations and Co-operation Among States in Accordance with the Charter of the United Nations, G.A. Res. 2625 (XXV), U.N. Doc. A/8082 (Oct. 24, 1970), *reprinted in* 9 I.L.M. 1292 (1970). Scholars have their own definitions as well. *See, e.g.*, ALEX P. SCHMID & ALBERT J. JONGMAN, POLITICAL TERRORISM 1–2 (1988) ("Terrorism is a method of combat in which . . . symbolic victims serve as an instrumental target of violence.").

227. KENNETH M. HEILMAN & EDWARD VALENSTEIN, CLINICAL NEUROPSYCHOLOGY 15 (2003) (describing effect of a lesion in Broca's area to speech and the relationship between other lesions and distinctive speech problems). Brain disease is more likely to lead to greater understanding of the normal function of the affected portion of the brain where the disease afflicts enough people, in a sufficiently consistent way, that it is possible to generalize about the impact of damage of a particular kind to a particular part of the brain. *See, e.g.*, R. Adolphs et al., *Impaired Recognition of Emotion in Facial Expressions Following Bilateral Damage to the Human Amygdala*, 372 NATURE 669 (1994); J.M. Gray et al., *Impaired Recognition of Disgust in Huntington's Disease Gene Carriers*, 120 BRAIN 2029 (1997); Reiner Sprengelmeyer et al., *Recognition of Facial Expressions: Selective Impairment of Specific Emotions in*

canards that contribute very little to understanding criminal violence. Although brain injuries can be catastrophic, there is no reliable relationship between pfc damage and violent or impulsive behavior. While in some cases "relatively large volumes of brain can be 'disconnected' without much obvious consequence," in other cases extremely small traumas of a few millimeters can "have devastating effects."[228] Brain injury continues to puzzle, and throws more caution than light on simplistic localization arguments about the functioning of intact brains.[229]

For these reasons, it is "surprising[ ]" that "a few scientists" have started to use pfc activity levels "as a referent for moral feeling or judgment."[230] While it is true that certain "[p]sychopaths who are shown an aggressive picture . . . display less activation" in the pfc than neurotypical people, the reverse is not true: "most adults with damage to, or compromise of, the orbitofrontal prefrontal cortex never commit a serious crime, whereas most who lie, cheat, and steal have perfectly intact brains."[231] This is not to say that brain trauma or disease could not produce dramatic personality changes; it could. The questions of how the brain reroutes around and compensates for injuries, and how it continues to change throughout a person's life, form a whole field of inquiry in their own right. The limited point here is just that isolated stories like those of Gage and Whitman may have less to say than is claimed about them or than at first it may appear.

C. Violence as a Legal Term and Psychological Construct

In order for violence to be localizable to activity in specific parts of the brain, or to particular brain dysfunctions, it must designate a coherent or homogenous thing. "Violence," however, designates a huge range of individual, group, and even national behavior.[232] What the law recognizes as violence changes greatly over time and place. Violence takes its meaning from the law, social norms, and the particular context in which the violent acts take place.[233]

Two relatively recent changes in the criminal law illustrate the legally-contingent nature of what a society calls "violence": the creation of the category of domestic violence and the proscription of

Huntington's Disease, 14 COGNITIVE NEUROPSYCHOLOGY 839, 839–40 (1997) (describing deficits in Huntington's patients with lesions to same portion of brain).

228. LEWONTIN ET AL., *supra* note 180, at 190.

229. Chorover, *supra* note 213, at 263 ("Brain lesions, whether the results of operations or accidents in humans, or in controlled animal experiments, have continued to produce puzzles and paradoxes.").

230. KAGAN, *supra* note 90, at 130.

231. *Id.*

232. LEWONTIN ET AL., *supra* note 180, at 91.

233. Elizabeth A. Stanko, *Introduction* to THE MEANINGS OF VIOLENCE 2–3 (Elizabeth A. Stanko ed., 2003).

one kind of sexual violence through the elimination of the marital rape exception. Prior to the latter quarter of the twentieth century, victims of abuse by intimates might have identified their abusers' conduct as violent—but legal culture did not. Until Pennsylvania passed its landmark Protection from Abuse Act in 1977, domestic violence was largely unrecognized and not separately legally actionable.[234] With the stroke of a legislator's pen, acts that previously did not rate the designation "criminal violence" suddenly became legally defined as such.

The marital rape exception tells the same story as to sexual violence in the home. Until relatively recently, state courts across the United States presumed that a husband had a right to sex at any time within marriage, regardless of the wife's actual consent.[235] After much legal and social contestation, this aspect of what previously was a conjugal right became redefined as marital rape; a husband who was exercising his legally-sanctioned rights one day became the perpetrator of criminal sexual violence the next. This was a change in the law, not a change in perpetrators' brains.[236] Today, in much of Asia and the Middle East, the marital rape exception endures;[237] thus, the same conduct that is "criminal violence" in one culture is not considered "violence" at all under the laws and mores of another. This small example illustrates that what counts as violence depends substantially on who gets to define it.

As discussed above, social unrest incident to the struggle for civil rights was a major impetus in the 1960s for calls for wide-spread lobotomy. Drs. Sweet, Mark, and Ervin explicitly linked their localization theory of violence to neurobiological differences in race rioters: because some African-Americans rioted and others did not, they reasoned, the only explanation for this distinction must lie outside the slum conditions in which both rioters and nonrioters lived. Rather, there must be a "brain proneness to violence"

234. EVE S. BUZAWA & CARL G. BUZAWA, DOMESTIC VIOLENCE: THE CRIMINAL JUSTICE RESPONSE 109 (2003) (describing history of enactment of anti-domestic violence legislation in the United States).

235. Rebecca M. Ryan, *The Sex Right: A Legal History of the Marital Rape Exemption*, 20 LAW & SOC. INQUIRY 941 (1995) (providing a history of the challenges to, and defeat of, marital rape exceptions in the United States). For a comprehensive treatment of this subject, see DIANA E.H. RUSSELL, RAPE IN MARRIAGE (1982).

236. Except to the extent that internalized norms might alter brain structure or function, on a materialist view of thought. So, a change in norms might cause a change in brain biology—but that is not the causal direction we find in arguments about the neurobiology of violence.

237. AIHWA ONG, NEOLIBERALISM AS EXCEPTION: MUTATIONS IN CITIZENSHIP AND SOVEREIGNTY 49–50 (2006) (discussing the marital rape exception under Islamic law and noting that many Asian legal scholars view the marital rape exception as an unacceptable "Western import"; the views of Asian and Muslim women on this subject, however, are not reported).

amongst those who rioted.[238]

Surely, the acts of rioters count as "violence" under any customary definition. However, Drs. Mark and Ervin notably failed to consider that mass injustices perpetrated by whites against African-Americans also might constitute "violence." No contemporary proposals were advanced to, for example, conduct neurobiological studies of white supremacist gangs or enthusiastic Southern sheriffs to determine the brain disorders underlying *their* predispositions to violence. Nor were any proposals for "therapeutic lobotomy" or "sedative neurosurgery" advanced for dealing with the then-widespread problem of white violence. Thus, while the laws at the time proscribed both rioting and the acts of individual violence by whites against blacks, only the conduct of one group appeared problematic; thus we see that *who* is described as violent, as well as what is described as violence, also depends on who is making the judgments.

Moving outside of legal definitions, violence may be understood better as a psychological construct than as a biological fact.[239] Psychological constructs describe general features observed across people, like "intelligence" or "memory,"[240] that are united by functional similarities, or family resemblances, more than by a common biology.[241] Psychologists do not consider these to be real "things" that can be measured in the same way as, for example, height, although they can be measured functionally.[242] Psychological constructs may be valuable, and may map well onto behavior; yet, it is well recognized that they may have no relationship to a particular

238. Mark et al., *supra* note 102, at 217.

239. A psychological construct "is a theoretical idea developed to explain and to organize some aspects of existing knowledge." It is a work of informed scientific imagination understood from its network of relationships. AM. PSYCHOLOGICAL ASS'N STANDARDS FOR EDUCATIONAL AND PSYCHOLOGICAL TESTS 29–30 (1974).

240. James R.P. Ogloff & Kevin S. Douglas, *Psychological Assessment in Forensic Settings*, *in* 10 HANDBOOK OF PSYCHOLOGY, 346, 355 (John R. Graham & Jack A. Naglieri eds., 2003).

241. The relationship between psychological constructs, on the one hand, and physical reality on the other, goes to the heart of profound issues in fields ranging from cognitive psychology and neuroscience to linguistics and philosophy. See, for example, HILARY PUTNAM, REPRESENTATION AND REALITY 7 (1988) (challenging Noam Chomsky's notion of mental modules). Putnam fires a shot over the bow at the notion that there is a correspondence between either mental states or psychological representations, and physical reality, stating that there is a "general tendency in the history of thought . . . to think of concepts as scientifically describable ('psychologically real') entities in the mind or brain. And it is this entire tendency that, I shall argue, is misguided." *Id.*

242. STEVEN J. OSTERLIND, CONSTRUCTING TEST ITEMS: MULTIPLE-CHOICE, CONSTRUCTED-RESPONSE, PERFORMANCE, AND OTHER FORMATS 36 (2d ed. 1998); *see also* KAGAN, *supra* note 90, at 42 (noting that psychological constructs "are theoretical inventions intended to explain behavior. They are not 'things in the brain'").

underlying biology at all.[243]

IV. NORMS AND NEURONS: TOWARD INTEGRATING BRAIN-LEVEL AND SOCIAL-LEVEL APPROACHES IN CRIMINAL LAW

At the start of this Article, I argued that similar beliefs have been at work in each of the past major criminal law and neuroscience movements and inform some of the current work that identifies the commission of violent offenses as emerging from brain-based pathology. This Part will unite past and current movements by exploring their common themes. It will then offer examples of how neuroscience could contribute to legal understandings of the causes of violent acts; these examples suggest an approach to incorporating neuroscience into criminal law that is less ambitious than a total brain-based theory of violence—but that may, for that very reason, prove more productive. Scholars like Elizabeth Phelps and Dame Susan Greenfield (among many others) examine the ways that beliefs and identities are formed on a neurological level; how people differentiate in-groups and out-groups; and how people use different kinds of emotions, like disgust, in making judgments about others. This work could inform approaches to the design of legal institutions to enhance prosocial behavior and reduce violent conflict, but it would not promise to provide clear answers "in the brain" for why violence happens.

The ideas at the end of this section are meant to be suggestive, not exhaustive, as there are many promising areas of collaboration, including those yet to be devised.

A. Uniting the Three Tenets

Understanding criminal violence primarily as brain-based rests on the notion that personal, social, and cultural phenomena—from an individual's actions to the way markets function—not only can be explained, but are caused and determined, by the make-up of the most basic physical components of a system. This is reductive materialism,[244] a way of thinking that aims to explain higher-level

243. The definition of a "psychological representation" is itself the subject of extensive dispute in the fields of psychology, linguistics, and philosophy. *See, e.g.*, Gregory McCulloch, *Mental Representation and Mental Presentation*, *in* LOGIC, THOUGHT AND LANGUAGE 22, 22–24 (Anthony O'Hear ed., 2002) (describing definitions of a "psychological representation" across several intellectual disciplines).

244. Calling this approach reductive is no slur—a majority of neuroscientists share a commitment to reductive materialism. Indeed, Michael Gazzaniga, a preeminent neuroscientist who coined the phrase "cognitive neuroscience," identifies reductionism (or reductive materialism) as the dominant mode of inquiry in this field and one with great investigatory and explanatory power. *See* Snead, *supra* note 10, at 1278 (quoting Michael S. Gazzaniga & Megan S. Steven, *Free Will in the Twenty-first Century: A Discussion of Neuroscience and the Law*, *in* NEUROSCIENCE AND THE LAW (Brent Garland ed., 2004)).

phenomena completely in terms of their lower-level components; it entails the belief that higher-level phenomena also are completely caused by lower-level phenomena.[245] Thus, according to a reductive materialist view of the brain ("neuropsychological reductionism" or neuroreductionism[246]), all "human thought and behavior" is best understood by examining "physical processes taking place inside the brain . . . ."[247]

Describing this school of thought, Professor Owen Jones writes:

> [A]ll choices emerge from the human nervous system. . . . The [nervous] system is composed of molecules, in turn composed of atoms, and it is driven by chemical reactions and electrical circuits. The nervous system and its brain are therefore part of a material world in which present events are caused by prior events, *extending back to the beginning of time and matter*.[248]

Those who subscribe to the strong reductionist position believe (or would agree) that the Big Bang contained within it all the information that has determined everything that has come after—that "the entire history of the stars [and] . . . the history of life as well" was "immanent in that millionth of a second when the universe began,"[249] including, among other things (or among everything) the emergence of life on earth, the evolution of human kind, and whether a particular person would commit a violent criminal offense. This is because "all choices emerge" from an unbroken chain of causation stretching back to "the beginning of time."[250] Translating this view to the relationship between brain, behavior, and society to understanding criminal violence leads to an

245. *Id*. at 1277 n.59 (citing PATRICIA SMITH CHURCHLAND, BRAIN-WISE: STUDIES IN NEUROPHILOSOPHY 20–21 (2002) ("[A] reduction has been achieved when the causal powers of the macrophenomenon are explained as a function of the physical structure and causal powers of the microphenomenon.")).

246. Chorover, *supra* note 213, at 266.

247. *Id.*; *see also, e.g.*, THE CAMBRIDGE DICTIONARY OF PHILOSOPHY 599–602 (Robert Audi ed., 1995) (defining materialism as the premise that only physical things exist and therefore that all phenomena must be explained in terms of material causes). For a fine comment exploring the implications of reductive materialism in criminal law, see Andrew E. Lelling, Comment, *Eliminative Materialism, Neuroscience and the Criminal Law*, 141 U. PA. L. REV. 1471 (1993).

248. Jones, *supra* note 123, at 93 (emphasis added).

249. RICHARD LEWONTIN & RICHARD LEVINS, BIOLOGY UNDER THE INFLUENCE: DIALECTICAL ESSAYS ON ECOLOGY, AGRICULTURAL, AND HEALTH 16 (2007) (critiquing the strong reductionist position).

250. Jones, *supra* note 123, at 93; *cf*. Patricia Smith Churchland, *Moral Decision-Making and the Brain*, *in* NEUROETHICS, *supra* note 19, at 3, 5–6 (describing the brain as a causal machine but noting that, due to its nature as a "complex . . . dynamical system," it may defy prediction; arguing that unpredictability does not arise because activity in the brain exists outside of physical causes but because causation is not simple in systems of this type).

individualistic approach in which the individual brain or even subregions of the brain are taken as the basic unit of analysis.[251]

Viewing criminality as the result of brain dysfunction—of biological difference between lawbreakers and nonlawbreakers—dovetails with the concept of alterity. "Alterity" is the construction of community through the identification and exclusion of the "Other."[252] Criminal law, a strongly normative discipline, is understood to reinforce community ideals by defining and excluding that which threatens the community, whether the threat is practical, normative, or both;[253] thus alterity is a significant concept within criminal law. The relationship between criminal law and alterity is at best an ambivalent one, however, because it is an aspiration (and perhaps a conceit) of liberalism that we judge the act and not the actor.[254] Accordingly, the normative criminal law in the liberal state is both prone to alterity and on its guard against it. The idea of the biological "Other," the "born criminal," satisfies the urge to alterize the criminal but also raises questions about the propriety—and relevance—of doing so in a system that at least aims to judge acts and not statuses.

Neuroscience approaches to legal issues can (but need not) feed into the concept of alterity in criminal law by defining people who commit crimes as biologically different. Alterity in past and current claims about violent offenders is not subtle. For Cesare Lombroso, the brain of the criminal resembled that of the "rat" or the "lower carnivore."[255] Psychointerventionalists of the mid-twentieth century compared violence in people to the behaviors of the "raging bull" or

251. Individualism is used here in the sense of taking the individual as ontologically prior to the social ("methodological individualism"). *See, e.g.*, LARS UDEHN, METHODOLOGICAL INDIVIDUALISM: BACKGROUND, HISTORY, AND MEANING 320–21 (2001). It is not used in the more general sense of "the assertion of one's own will or personality." *See* AMERICAN HERITAGE DICTIONARY 656 (2d ed. 1991); *see also* Chorover, *supra* note 213, at 264 (arguing that the psychointernventionalists, like lobotomists, made the error of looking at individual brains in isolation for the solutions to social problems).

252. Raymond Corbey & Joep Leerssen, *Studying Alterity: Backgrounds and Perspectives*, *in* ALTERITY, IDENTITY, IMAGE iv (Raymond Corbey & Joep Leerssen eds., 1991) (describing alterity and its role in societies' self-definition).

253. Paul H. Robinson, *Why Does the Criminal Law Care What the Layperson Thinks Is Just? Coercive Versus Normative Crime Control*, 86 VA. L. REV. 1839, 1840 (2000) ("[T]he extent of criminal law's moral authority determines the extent of its ability to shape community norms and to influence people's conduct through normative forces.").

254. Dan M. Kahan, *The Secret Ambition of Deterrence*, 113 HARV. L. REV. 413, 414–15 (1999).

255. *See infra* Part I.A.2 for a discussion of Lombroso's work. For a comprehensive treatment of scientific racism, focusing particularly on brain difference, see generally Gould, *supra* note 54. For another excellent critique of past scientific racism by a leading biologist of violence, see DEBRA NIEHOFF, THE BIOLOGY OF VIOLENCE 2–20 (1999).

the "predatory and vicious lynx" and "wolverine."[256] The racial dimension present in past episodes also speaks to the notion of the violent person as the biological "Other." As discussed above, Drs. Mark, Ervin, and Sweet explicitly linked their localization theory of violence—and their recommendation of mass lobotomy—to putative neurobiological differences in race rioters. The absence of any consideration of the neurobiology of white violence toward African-Americans suggests that they *ex ante* viewed their subjects (however subconsciously) as Other.

The express and implied racism of earlier criminal law-brain science movements emphatically is not present in current work in the field. Scholars are extremely careful to distinguish their work from the race-based premises and applications of brain sciences in criminal law in past eras.[257] Furthermore, none of the current work focuses on racial difference, nor have any scholars differentially focused on any racial groups. Absent the racial dimension, however, alterity remains implicit in current claims that locate criminal violence in brain difference. If behavior is determined by brain structure and function (holding aside for the moment the causes and fixity of such difference), and a person behaves in ways that deviate from the norm, then that difference must be biological difference; this makes the offender the "Other."

In constructing violence as a biological feature of violent offenders, historical and some modern localization stories offer a comforting answer to the problem of evil: there are no evil people, just dysfunctional brains. One of the most common reactions to horrific acts of violence is to ask how a person (or people) could do such a thing. Extreme acts of violence are, most of the time and to most people, incomprehensible. Such acts pose hard questions. Perhaps the only easy or comforting answer is that such acts are the product of real, literal sickness: "Crime is . . . pathological";[258] "Crime [is] a disease."[259]

256. MARK & ERVIN, *supra* note 77, at 29. Sampling here just some of the work summarized and relied upon by Mark and Ervin, *id.* at 38–46: B.N. Brunnell et al., *Septal Lesions and Aggressiveness in the Cotton Rat, Sigmodon Hispidus*, 6 PSYCHONEUROLOGICAL SCI. 443 (1966); M. David Egger & John P. Flynn, *Effects of Electrical Stimulation of the Amygdala on Hypothamically Elicited Attack Behavior in Cats*, 26 J. NEUROPHYSIOLOGY 705 (1963); H. Ursin & B. Kaada, *Functional Localization within the Amygdaloid Complex in the Cat*, 12 EEG CLINICAL NEUROPHYSIOLOGY 1 (1960); Lawrence Weiskrantz, *Behavioral Changes Associated with Ablation of the Amygdaloid Complex in Monkeys*, 49 J. COMP. PHYSIOLOGY PSYCHOL. 381 (1956).

257. VOLAVKA, *supra* note 1, at xi–xiv. Volavka himself was imprisoned in a Nazi camp as a child and has written eloquently about the falsity and dangers of racial stereotypes, biological and otherwise. *Id.* at vii.

258. MCCORMICK, *supra* note 74, at 560.

259. Kirchmeier, *supra* note 4, at 634.

B. Turning the Premises Around: Toward Integrating Norms and Neurons

The criminal law's resurgent attention to neuroscience offers an opportunity for collaboration that does not recapitulate past problems rooted in determinism and alterity. While accepting that all behavior is produced by the brain,[260] work of the kind discussed here explores how the criminal law could use this knowledge at levels ranging from the individual to the general, and to clarify the contributions of both pathology and normalcy to the commission of violent offenses. Two areas of inquiry, below, on intragroup-intergroup biases and on the role of emotions in decision-making, suggest that neuroscience research can help illuminate the presence of basic neural systems that become socially shaped; this suggests that the law may not be able to eradicate the sometimes dangerous predispositions that arise from these systems but could leverage them in more useful ways. This section closes with some suggested avenues for future research.

1. In-Groups and Out-Groups, Identity, and Violence

"Can we all get along?"[261] Rodney King uttered this famous plea when riots rocked Los Angeles after an all-white jury acquitted police officers of severely beating Mr. King. Mr. King's question is a perennial one, as is the problem of intergroup violence and subjugation. Recent cognitive neuroscience studies suggest that people are primed to make self-other distinctions[262]—but that who we see as "self" and who we see as "other" are strongly socially influenced[263] as well as subject to change through experience and learning.[264]

260. Reflexes still may be observed in the absence of any brain functioning other than the brain stem, as in infants born with anencephaly; reflexes, though, are not "behavior." *See, e.g.*, C.P. PANTELIADIS & B.T. DARRAS, ENCYCLOPEDIA OF PEDIATRIC NEUROLOGY 367 (2000) (describing reflexes in anencephalic infants).

261. Rodney King, Statement on Los Angeles Riots (May 1, 1992), http://www.youtube.com/watch?v=aMfr2CgIPhg (last visited Mar. 4, 2009).

262. James K. Rilling et al., *Social Cognitive Neural Networks During In-Group and Out-Group Interactions*, 41 NEUROIMAGE 1447, 1447–48 (2008).

263. Li Zhang et al., *In Search of the Chinese Self: An fMRI Study*, 49 SCI. CHINA: SERIES C. LIFE SCI. 89, 89–90 (2006) (describing brain regions involved in reflection on self, related other (mother), and abstract other (cartoon character)).

264. *See, e.g.*, Mary E. Wheeler & Susan T. Fiske, *Controlling Racial Prejudice: Social-Cognitive Goals Affect Amygdala and Stereotype Activation*, 16 PSYCHOL. SCI. 56, 56–57 (2005) (discussing results of fMRI study showing that in-group/out-group perception is changed based on task and finding that race can be salient in the default condition, but subjects will quickly reorganize in-group/out-group based on instructions to attend to age, gender, or the presence of differently-colored dots on photos of strangers' faces).

Because much violence involves intergroup conflict, as well as conflict between individuals of perceived different groups, scholars in criminal law may look to the developing neurobiological literature on intragroup-intergroup identification, belief, and identity to reduce destructive group bias and conflict.[265] It is unlikely that there are distinct brain-based predispositions or pathologies subserving all the violent offenses from hate crimes to gang behavior to terrorism to ethnic and political violence; yet, self-other and intragroup-intergroup distinctions may play some role in all of them. Functional imaging studies show that fear conditioning is easier to establish and harder to erase relative to members of the "other" group than to one's own group: subjects in the lab learn positive associations faster and negative associations more slowly as to members of their own groups; conversely, negative views of the members of the "other" group persist much longer than toward members of one's own group, even in light of contrary information.[266]

This work on the difference between us-them perception raises the question of how these beliefs come to be incorporated physically by the subject[267]—and how these kinds of beliefs may relate to acts of violence. Examining how beliefs come to be laid down in the brain, researchers are finding that ideas with a belief-based component are both easier to remember and harder to overcome than ideas communicated through fact or logic.[268] Everyone has experienced that strong emotion ("high arousal") makes a much stronger mark in one's mind than dry facts; this metaphorical sense appears to be literally true in fMRI studies of belief and memory formation.[269] One's basic beliefs appear to become encoded into the brain through a combination of high-arousal experiences and through repetition.[270] Institutionalized religious practices incorporate both of these features, with emotional stories and ceremonies (high arousal), and prayers, memorization of texts or creeds, and chanting (high repetition).

265. While work on the neuroscience of group bias has not yet been applied within criminal law scholarship, it has been applied to general questions of institutional design, see, for example, Goodenough, *supra* note 18, and Hill & O'Hara, *supra* note 16.

266. Elizabeth A. Phelps et al., *Performance on Indirect Measures of Race Evaluation Predicts Amygdala Activation*, 12 J. COGNITIVE NEUROSCIENCE 729, 730–31 (2000).

267. Damian Stanley et al., *The Neural Basis of Implicit Attitudes*, 17 CURRENT DIRECTIONS PSYCHOL. SCI. 164, 165 (2008) (discussing an fMRI imaging study of same).

268. Sam Harris et al., *Functional Neuroimaging of Belief, Disbelief, and Uncertainty*, 63 ANNALS NEUROLOGY 141 (2008); Oliver Sacks & Joy Hirsch, Editorial, *A Neurology of Belief*, 63 ANNALS NEUROLOGY 129 (2008).

269. Audio recording: Dame Susan Greenfield, Remarks on the Science of Terrorism, Australian Science Media Centre (Aug. 21, 2006), *available at* www.aussmc.org/The_Science_of_Terrorism.php.

270. Sacks & Hirsch, *supra* note 268.

There may be a relationship, Dame Susan Greenfield speculates, between the degree of individualism of a person's identity and the degree of autonomic arousal and aversion the person will feel in response to threats or risks to self.[271] A person with a more collective identity may perceive threats or insults to the group more like a threat to the self; conversely, he or she may perceive a risk to the self that does not implicate the group as less comparatively alarming or aversive.[272] If religion were used to inculcate collective-focused beliefs, through high-arousal experiences and repetition, such beliefs would be difficult to dislodge through appeals to fact, logic, or self-interest. This work does not suggest that some cultural beliefs predispose any person to violence. But it may suggest that people from cultures that promote group identification will perceive threats or slights to the culture as if they were directed at the individual; they also may be more willing to take individual risks on behalf of the cultural group.[273]

Greenfield's description of how neural processes mediate and are mediated by cultural processes may not provide an explanation for why some people become suicide-terrorists: not only does she recognize the attenuated relationship between belief and identity, and identity and risk perception, but also the large leap from reduced individual risk aversion to committing self-destructive violence. Furthermore, her remarks are speculative and require much additional investigation. But her approach offers a plausible account of why suicide-terrorism, or other self-destructive ways of perpetrating group or political violence, like the Japanese *tokubetsu kōgeki tai* (kamikaze), appear more commonly in cultures that expressly value strong religious or national identification.

This way of relating neuroscientific findings to individual violent crimes notably does not conform to the three themes or tenets that have run through prior criminal law-brain science movements: it does not posit any putative violence-related brain dysfunction in the perpetrator; does not view violence as a thing that can be localized to a specific part of the brain; and, although it explores how cultural differences may relate to individual behavior, does not construe the perpetrator of a violent act as essentially different from people who do not commit such acts. Furthermore, under this view, it would not be possible to put an individual into a scanner, identify an under- or over-active brain region, and then use such a scan as a prediction technique of future violent conduct in the pre- or post-conviction setting. Rather, it construes violence of a specific type as the end of an array of interactions between brain, culture, and political context, and explores how those factors relate

271. Greenfield, *supra* note 269.

272. *Id*.

273. *Id.* (explaining how, in Greenfield's more colorful formulation, "individual[s] can self-destruct and it does not matter").

to individual responses to risk to the self; in other words, such studies on belief formation show how neurons and norms literally come together.

2. A Few More Avenues

There are myriad ways neuroscience could contribute to criminal law, ranging from general models of emotion and behavior to specific analyses of particular punishments and rehabilitation strategies. In such a new and developing field, it would be impossible (as well as an act of hubris) to try to predict all of the potential avenues of research. A few of these future avenues could include work on preventing criminal behavior, designing individual sentences and general penalties in a more informed manner, and rehabilitating offenders.

As a threshold matter, it could be useful to investigate the nonpathological pathways that lead to violence, like confinement and frustration. The existence of "air rage" and "road rage" suggest that there are situations or structures that predictably stress people beyond their capacity for self-control. If we were to better understand the general conditions that provoke aggression, we might be able to design systems that help minimize such triggers. This moves us from the notion of violence-as-pathology to a more general understanding of our capacity for violence under given conditions.

Neuroimaging could perhaps help describe what types of behaviors or beliefs that lead to violence are more readily changeable or malleable. When experimental psychologists teach an animal a conditioned response—like the expectation of a reward in response to a tone—and then teach the animal to "unlearn" that response, they call it "extinguishing" the response.[274] What neurobiological factors make certain behaviors or beliefs easier or harder to "extinguish"? And how would that vary based on individual factors, like motivation? Conversely, there may be some behaviors that may be particularly resistant to change. In both cases, such information might have predictive value as to recidivism as well as suggest which offenders would benefit most from rehabilitation strategies.

Another area may be juvenile justice. As the landmark decision in *Roper v. Simmons*[275] recently acknowledged in holding unconstitutional the death penalty for offenders who committed their offenses as juveniles,[276] research shows that different parts of the brain mature at different ages.[277] While the Court focused on the

274. Nestor A. Schmajuk, *Conditioning*, *in* THE HANDBOOK OF BRAIN THEORY AND NEURAL NETWORKS 256, 256–58 (Michael A. Arbib ed., 2d ed. 2003) (describing conditioned responses and their extinguishment).

275. 543 U.S. 551 (2005).

276. *Id*. at 568.

277. *Id*. at 574.

"diminished culpability of juveniles,"[278] this research also raises the question of whether juveniles are more amenable to rehabilitation than adults. If so, that would suggest a reconsideration of the punitive emphasis in much of the juvenile system. Furthermore, it might be possible to model effects of punishment on juveniles on a neurological level: what are the effects on developing brains of being exposed to conditions of punishment, and do those differ from effects on adult brains?

The neurological impact of conditions of confinement could be investigated as well. It is well known observationally that extended solitary confinement seriously affects mental health.[279] Hypothetically, if it could be determined that extended solitary confinement causes neurological changes known to be associated with severe stress and with certain mental illnesses, like cell death in the hippocampus, that might provide grounds to set limits on certain conditions of confinement. This would move out of research on the causes of violence by individuals, but would consider whether the state does undue violence through methods of punishment.

CONCLUSION

Albert Einstein wrote that the best models should be "as simple as possible, but no simpler."[280] The claim that the criminal law can understand violence principally as emerging from localized brain dysfunction in people who are neurobiologically distinct is simpler than possible. The brain is a physical manifestation of the interaction between biology and society; our increasing understanding of its plasticity and function may lead us to conclude that it is impossible to fix a biological nature apart from a social existence. A "more unified picture of brain-behavior relationships and [of] the nature of human problems" would integrate "the overlapping aspects of existence represented by the organization of the brain, the individual, and the society."[281] The challenge in this time period, in this particular episode of the affair between criminal law and neuroscience, is to use neuroscience not to craft attractive simplifications but to shed a measure of light on complex and multifaceted realities.

278. *Id*. at 571.

279. *See* Stuart Grassian, *Psychiatric Effects of Solitary Confinement*, 22 WASH. U. J.L. & POL'Y 325, 327 (2006); Craig Haney, *Mental Health Issues in Long-Term Solitary and "Supermax" Confinement*, 49 CRIME & DELINQUENCY 124, 130–32 (2003) (citing forty-six studies describing psychiatric and physiological effects of extended solitary confinement, including hallucinations and hypertension).

280. *Quoted in* Brian Greene, *"That Famous Equation and You," in* E = EINSTEIN: HIS LIFE, HIS THOUGHT AND HIS INFLUENCE ON OUR CULTURE 287, 292 (Donald Goldsmith & Marcia Bartusiak eds., 2006).

281. Chorover, *supra* note 213, at 264–65.