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Court Review

Volume 50, Issue 2

THE JOURNAL OF THE AMERICAN JUDGES ASSOCIATION

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Court Review

THE JOURNAL OF THE AMERICAN JUDGES ASSOCIATION
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EDITOR'S NOTE

The articles in this special issue of *Court Review* provide the reader with a broad introduction to the emerging field of Law and Neuroscience. Many of these articles are specifically adapted and updated from previous publications for *Court Review* readers; others were written specifically for this issue.

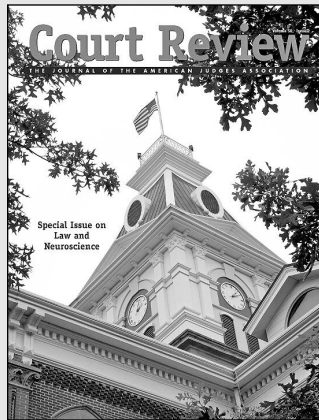
The special issue begins with an overview article by professors Owen Jones, Joshua Buckholtz, Jeffrey Schall, and René Marois—whose collective expertise spans law, biology, psychology, and neuroscience—surveying the ways in which brain science has been, and continues to be, integrated into law. The next article, by law professor David Faigman, places attention on one of the most difficult challenges inherent in neurolaw: what can the legal system reasonably infer about individuals before the court from group-based neuroscience data?

The next article, by lawyer and psychiatrist Susan Rushing, explores questions of admissibility in the illustrative context of Positron Emission Tomography (PET), which courts have encountered for some years. The issue then shifts to consider two special topics where neuroscience research may have great import for law: adolescent brain development and pain. Psychologist Laurence Steinberg, a leading authority on adolescent development, discusses how the science should (and should not) be applied. Law professor Amanda Pustilnik then explores both the promise and limitations of using pain neuroimaging research to resolve legal disputes.

Law professor and psychologist Stephen Morse looks to the future of neurolaw in the next article, cautioning against over-enthusiasm but pointing out areas where neuroscience contributions may be most salient.

The issue concludes with law professor Francis Shen's essay summarizing a compendium of resources, for background information or for more extensive consultation, related to neuroscience in the courtroom.

The preparation of this special issue was aided, in part, by support from the *MacArthur Foundation Research Network on Law and Neuroscience* (www.lawneuro.org).—Francis X. Shen and Owen D. Jones



Court Review, the quarterly journal of the American Judges Association, invites the submission of unsolicited, original articles, essays, and book reviews. *Court Review* seeks to provide practical, useful information to the working judges of the United States and Canada. In each issue, we hope to provide information that will be of use to judges in their everyday work, whether in highlighting new procedures or methods of trial, court, or case management, providing substantive information regarding an area of law likely to be encountered by many judges, or by providing background information (such as psychology or other social science research) that can be used by judges in their work. Guidelines for the submission of manuscripts for *Court Review* are set forth on page 61 of this issue. *Court Review* reserves the right to edit, condense, or reject material submitted for publication.

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Cover photo, Mary S. Watkins (maryswatkins@mac.com). The cover photo is the Page County Courthouse in Clarinda, Iowa, designed by architect William Foster and built in 1887. It was listed on the National Register of Historic Places in 1981.

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President's Column

A RECIPE TO MOVE AJA FORWARD

Elliott Zide

I write this message energized by the exciting AJA midyear meeting and Scottsdale, Arizona, the site of the meeting. Over the course of the two-and-a-half days spent together networking with colleagues, getting reacquainted with longtime AJA friends, and making new ones, we were able to spend time in structured sessions celebrating our achievements and planning new strategies to move AJA forward. We learned new skills and ways of thinking to make better judges. Based on the evaluations, all of the planning and education sessions received “excellent” ratings both for content and faculty/facilitator skills.

AJA remains the largest and possibly the most robust judicial organization representing boots-on-the-ground judges in the United States and Canada. We are well branded as the Voice of the Judiciary® and are preeminent at Making Better Judges®. This was confirmed when we reviewed our achievements over the last 10 years.

We benefit from the considerable volunteer efforts of individual members of our organization. So, in case you ever wonder about the truth of the adage “what goes around, comes around,” consider this: Kevin Burke was not able to be in Scottsdale because he was pursuing AJA’s branding in the area of procedural fairness by speaking to judges at a conference in my home state of Massachusetts. When he was finished, he sent me the following text:

I had [a] terrific experience [in Massachusetts]. Several years ago, a Massachusetts judge set bail on a guy who went on a killing spree in Seattle. It was, as you may recall, horrific. Mitt Romney attacked her. Steve Leben and I wrote a commentary for the *Seattle Times* defending her. Neither Steve nor I knew her. We just thought she was a judge in need of a defense. When the article was published, I never heard from her. But when I came in the room yesterday, she sought me out and was pretty pro-

fuse in her thanks. She said it was a hard time for her. She had stopped reading newspapers and watching the news. Her husband found the article and said: “You should read this.” That exchange with her made the trip to Boston worthwhile. Thanks for getting me there.

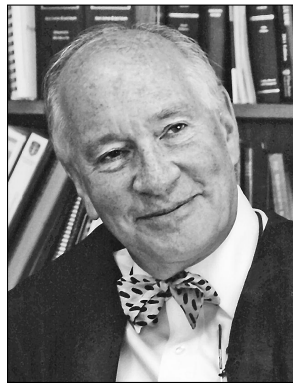
This is just one example of the work our members do to make AJA a voice for judges.

But Scottsdale was more than just feeling good about the past. The enthusiasm expressed during the participatory planning and education sessions carried forward to the business portions of the conference where AJA’s entire leadership committed to working in a more focused and robust way to achieve the following four goals:

1. Be a stronger and clearer voice BOTH of and for the judiciary.
2. Make better judges.
3. Provide and promote more innovative and high-quality educational opportunities for judges and the public.
4. Play a key role in fulfilling the promise of justice for all by advocating for and promoting strategies that evidence supports as being effective in improving the administration of justice.

To help achieve these goals, AJA’s leadership understands that AJA must retain its membership, revitalize the commitment of members to the goals of the organization, and increase the number of members. AJA is committed to the principle that AJA does its best work at making better judges when we work together in robust ways to make each other better judges. That is our recipe to make AJA grow and prosper. So look at our website—www.amjudges.org—to learn more specifics about our good work.

I’m proud of our organization and proud to represent it.



Brain Imaging for Judges:

An Introduction to Law and Neuroscience

Owen D. Jones, Joshua W. Buckholtz, Jeffrey D. Schall, & René Marois

It has become increasingly common for brain images to be proffered as evidence in civil and criminal litigation.¹ This article offers some general guidelines to judges about how to understand brain-imaging studies—or at least avoid misunderstanding them. (An appendix annotating a published brain-imaging study, in order to illustrate and explain, with step-by-step commentary, is available in the full text online.²)

Brain images are offered in legal proceedings for a variety of purposes, as Professors Carter Snead and Gary Marchant have usefully surveyed.³ On the civil side, neuroimaging has been offered in constitutional, personal injury, disability benefit, and contract cases, among others. For example, in *Entertainment Software Ass'n v. Blagojevich*,⁴ the court considered whether a brain-imaging study could be used to show that exposure to violent video games increases aggressive thinking and behavior in adolescents. In *Fini v. General Motors Corp.*,⁵ brain scans were proffered to help determine the extent of head injuries from a car accident. In *Boyd v. Bert Bell/Pete Rozelle NFL Players Retirement Plan*,⁶ a former professional football player proffered brain scans in an effort to prove entitlement to neuro-degenerative disability benefits. And in *Van Middlesworth v. Century Bank & Trust Co.*,⁷ involving a dispute over the sale of land, the defendant introduced brain images to prove mental incompetency, resulting in a voidable contract.

In criminal cases, brain images are sometimes invoked to support an argument that a defendant is incompetent to stand

trial. In *United States v. Kasim*, for example, Kasim was found to be demented, and incompetent to stand trial for Medicaid fraud, on the basis of medical testimony that included brain images.⁸ Brain images are also increasingly proffered by the defense at the guilt-determination phase, in an effort to negate the *mens rea* element of a crime, and to thereby avoid conviction. For example, in *People v. Weinstein*,⁹ a defendant accused of strangling his wife and throwing her from a 12th floor window sought to introduce images of a brain defect, in support of an argument that he was not responsible for his act. And in *People v. Goldstein*,¹⁰ a defendant sought to introduce a brain image of an abnormality, in an effort to prove an insanity defense, after he pushed a woman in front of a subway train, killing her.

Brain images have also been proffered at the sentencing phase of criminal cases, in furtherance of mitigation. For example, in *Oregon v. Kinkel*,¹¹ a boy convicted of killing and injuring fellow students in a high school cafeteria sought to introduce brain images of abnormalities, in an effort to secure a more lenient sentence. Brain images have been offered—in *Coe v. State*,¹² for example—to argue that a convicted murderer is not competent to be executed. And accessibility to brain-imaging technology has even been litigated—in *Ferrell v. State*¹³ and *People v. Morgan*¹⁴ for instance—in the context of a claim that a defense counsel's failure to procure a brain image for the defendant amounted to ineffective assistance of counsel.

For better or worse, the full complement of cases at the

This article is reprinted and adapted with permission from: Owen D. Jones, Joshua W. Buckholtz, Jeffrey D. Schall & René Marois, *Brain Imaging for Legal Thinkers: A Guide for the Perplexed*, 2009 STAN. TECH. L. REV. 5, for the convenience of the reader who would benefit from background information about neuroscience and the law prior to reading the other articles in this issue. The full text of the article, including an example of how to read a brain-imaging study, is available online at: <http://ssrn.com/abstract=1563612>. Additional background materials have been collected by the *MacArthur Foundation Research Network on Law and Neuroscience*: <http://lawneuro.org/resources.php>, and in extensive coursebook materials, OWEN D. JONES, JEFFREY D. SCHALL & FRANCIS X. SHEN, LAW AND NEUROSCIENCE (2014) (www.vanderbilt.edu/lawbrain).

Footnotes

1. For an overview of issues, see Jeffrey Rosen, *The Brain on the Stand*, N.Y. TIMES MAG., Mar. 11, 2007, at 49; Stacey A. Tovino, *Functional Neuroimaging and the Law: Trends and Directions for Future Scholarship*, 7 AM. J. BIOETHICS 44 (2007). A sampling of the rapidly growing scholarship at the law/neuroscience intersection appears *infra* note 31. Professor Shen's article in this issue provides an updated compendium of useful resources. Francis X. Shen, *Keeping Up with Neurolaw: What to Know and Where to Look*, 50 CT. REV. 64 (2014).
2. The article annotated is: Joshua W. Buckholtz, Christopher L. Asplund, Paul E. Dux, David Zald, John C. Gore, Owen D. Jones & René Marois, *The Neural Correlates of Third-Party Punishment*,

60 NEURON 930 (2008).

3. A very useful survey, on which we draw in part in the paragraphs that follow, has been prepared by Professor Carter Snead. See CARTER SNEAD, NEUROIMAGING AND THE COURTS: STANDARD AND ILLUSTRATIVE CASE INDEX (2006), <http://tinyurl.com/sneadlink>. Our research also benefitted from Gary Marchant, *Brain Scanning and the Courts: Criminal Cases*, Presentation to the Research Network on Legal Decision Making, MacArthur Foundation Law and Neuroscience Project (Oct. 11, 2008).
4. 404 F. Supp. 2d 1051 (N.D. Ill. 2005).
5. No. 227592, 2003 Mich. App. LEXIS 884 (Mich. Ct. App. Apr. 8 2003).
6. 410 F.3d 1173 (9th Cir. 2005).
7. No. 215512, 2000 Mich. App. LEXIS 2369 (Mich. Ct. App. May 5, 2000).
8. *United States v. Kasim*, No. 2:07 CR 56, 2008 U.S. Dist. LEXIS 89137 (N.D. Ind. Nov. 3, 2008). See also *McMurtey v. Ryan*, 539 F.3d 1112 (9th Cir. 2008); *United States v. Gigante*, 982 F. Supp. 140 (S.D.N.Y. 1997).
9. 591 N.Y.S.2d 715 (N.Y. Sup. Ct. 1992).
10. 786 N.Y.S.2d 428 (N.Y. Sup. Ct. 2004), *overruled on other grounds*, 6 N.Y.3d 119, 843 N.E.2d 727, 2005 N.Y. LEXIS 3389 (2005).
11. 56 P.3d 463 (Or. Ct. App. 2002).
12. 17 S.W.3d 193 (Tenn. 2000).
13. 918 So. 2d 163 (Fla. 2005).
14. 719 N.E.2d 681 (Ill. 1999).

intersection of neuroscience and law is now too large for comprehensive overview—in part because many of the cases do not result in reported decisions.¹⁵ While there is no denying that brain imaging is a powerful tool, whether used for medical or legal purposes, it is also clear that, like any tool, brain imaging can be used for good or for ill, skillfully or sloppily, and in ways useful or irrelevant.

We are concerned that brain imaging can be misused by lawyers (intentionally or unintentionally) and misunderstood by judges and jurors. Consequently, our aim in this article is to provide information about the operation and interpretation of brain-imaging techniques, in hopes that it will increase the extent to which imaging is properly interpreted, and conversely decrease the extent to which it is misunderstood or misused.

Part I of the article provides some very brief background on modern brain imaging, with particular emphasis on one widespread and powerful technique, known as functional magnetic resonance imaging (fMRI). The physics of fMRI, and the statistics accompanying the analyses that generate brain images, are complicated. We will make no effort to provide a comprehensive or detailed exploration of the subject. There are many existing textbooks that cover this material to great depths, often far greater than judges will need to master, for the specific contexts in which brain images are (potentially) legally relevant.¹⁶

Instead, we will aim here to focus on what a judge needs to know in order to have a basic understanding of what works how and why. Our goal is to present this in an accessible way, recognizing (as we trust our readers to allow us) that simplifying discussions are illustrative of general principles, but obviously ignore the richer detail that enables deeper appreciation of important caveats and subtleties.

Part II of this article then turns to provide, in brief and accessible overview, a variety of key concepts to understand about the legal, biological, and brain-imaging contexts at this particular law/neuroscience intersection, as well as a variety of guidelines we (and in some cases others) recommend to help avoid the var-

ious factual errors, logical traps, and analytic missteps that can all too quickly lead away from sound and sensible understandings of what brain images can mean—and equally what they cannot. Make no mistake: we are not the only researchers concerned about potential misunderstandings of brain images.¹⁷ A great many cautions have been swirling about in the literature, often offering multiple versions of key and basic points about the limitations of the technologies, and we hope here to distill some of those, add others, and explain the set in a way that we hope provides a concise and useful introduction to judges approaching this interdisciplinary nexus for the first time.

The online appendix to this article then provides a concrete illustration of how to read an fMRI study. We will not overclaim. Some of the details of fMRI defy short descriptions, involve technical details unlikely to be relevant in legal contexts, or both. On the other hand, much of the technical jargon, and many of the basic concepts one will encounter in an fMRI study, are clear with just a little explanation, oriented toward the audience we anticipate. We attempt to provide this in an accessible, informative way—assuming no particular scientific sophistication of the reader.

Specifically, the core of the online appendix is a 2008 fMRI study (co-authored by three of us and others) that used fMRI techniques to investigate how brains are activated during punishment decisions. Though we do not anticipate that the substantive findings will necessarily find immediate utility in litigation, we believe that judges reading an fMRI study will learn most from a study that inherently addressed matters relevant to law—in this case, the decision whether or not to punish someone for criminal behavior and, if so, how much.

“We are concerned that brain imaging can be misused by lawyers. . . and misunderstood by judges and jurors.”

15. One of the many efforts underway, within the MacArthur Foundation Law and Neuroscience Project, is a study by Hank Greely and Teneille Brown to find all actual and attempted uses of neuroimaging in criminal cases in California after January 1, 2006, regardless of whether such uses are mentioned in published opinions.

16. See, e.g., SCOTT A. HUETTEL ET AL., *FUNCTIONAL MAGNETIC RESONANCE IMAGING* (2d ed. 2009); ALFRED L. HOROWITZ, *MRI PHYSICS FOR RADIOLOGISTS: A VISUAL APPROACH* (3d ed. 1995); *FUNCTIONAL MRI: AN INTRODUCTION TO METHODS* (Peter Jezzard et al., 2001). Useful introductions to broader cognitive neuroscience, of which brain imaging is but a part, appear in: MICHAEL S. GAZZANIGA ET AL., *COGNITIVE NEUROSCIENCE: THE BIOLOGY OF THE MIND* (3d ed. 2008); JAMIE WARD, *THE STUDENT’S GUIDE TO COGNITIVE NEUROSCIENCE* (2006); *ESSENTIALS OF NEURAL SCIENCE AND BEHAVIOR* (Eric R. Kandel et al. eds., 1995); MARIE T. BANICH, *COGNITIVE NEUROSCIENCE AND NEUROPSYCHOLOGY* (2d ed. 2004); MARK F. BEAR ET AL., *NEUROSCIENCE: EXPLORING THE BRAIN* (3d ed. 2006); *NEUROSCIENCE* (Dale Purves et al. eds., 4th ed. 2007).

17. The limits of brain-imaging techniques are widely known to brain-imaging researchers, and many brain-imaging researchers are broadly concerned about misunderstandings among laypeople. A non-exhaustive list of important cautionary and explana-

tory articles, which have influenced some of our approaches below, include: John T. Cacioppo et al., *Just Because You’re Imaging the Brain Doesn’t Mean You Can Stop Using Your Head: A Primer and Set of First Principles*, 85 J. PERSONALITY AND SOC. PSYCHOL. 650 (2003); Dean Mobbs et al., *Law, Responsibility, and the Brain*, 5 PLoS BIOLOGY 693 (2007); Eric Racine et al., *fMRI in the Public Eye*, 6 NATURE REVIEWS NEUROSCIENCE 159 (2005); J.D. Trout, *Seduction Without Cause: Uncovering Explanatory Neurophilia*, 12 TRENDS COGNITIVE SCI. 281 (2008); Society of Nuclear Medicine Brain Imaging Council, *Ethical Clinical Practice of Functional Brain Imaging*, 37 J. NUCLEAR MED. 1256 (1996); Michael S. Gazzaniga, *The Law and Neuroscience*, 60 NEURON 412 (2008); Joseph H. Baskin et al., *Is a Picture Worth a Thousand Words? Neuroimaging in the Courtroom*, 33 AM. J.L. & MED. 239 (2007); Russell A. Poldrack et al., *Guidelines for Reporting an fMRI Study*, 40 NEUROIMAGE 409 (2008); Nikos K. Logothetis, *What We Can Do and What We Cannot Do with fMRI*, 453 NATURE 869 (2008); WILLIAM R. UTTAL, *NEUROSCIENCE IN THE COURTROOM: WHAT EVERY LAWYER SHOULD KNOW ABOUT THE MIND AND THE BRAIN* (2008). One of the works most critical of how brain-imaging results can be interpreted is WILLIAM R. UTTAL, *THE NEW PHRENOLOGY: THE LIMITS OF LOCALIZING COGNITIVE PROCESSES IN THE BRAIN* (2003).

“The physical principles underlying fMRI are quite complex.”

To facilitate that learning in this concrete application, the *Stanford Technology Law Review* generously afforded us the unique opportunity to annotate the article in the margin with explanations of various terms and contexts, as they appear throughout the study.

I. BRAIN IMAGING: A VERY BRIEF OVERVIEW

There are many kinds of brain images. All readers are likely familiar with the way x-rays, and the closely aligned technique known as computed tomography (CT) scanning, can show various structural anomalies in the body, including in the brain. In these techniques, radiation aimed at and passing through the body forms images on photographic film. The varying density of different tissues in the body results in varying levels of radiation reaching the film—creating, in turn, an image of internal structures. (For example, bone tissue appears as white, while soft tissue appears gray.) CT scanning varies from conventional x-rays by virtue of collecting images from multiple angles rotating around the body, which images are then combined by computers into cross-sectional representations. These techniques (like magnetic resonance imaging, which will be discussed in a moment) are used for information about how various parts of the body are structured. They can show whether structures are intact, and can reveal damage, atrophy, intrusions, and developmental anomalies. They do not, however, collect or provide information about how those body parts are actually functioning.

PET, which refers to positron emission tomography, is one of the techniques that enable researchers to learn about how the brain *functions*, as it is actually doing so. With PET, a researcher injects a subject with radioactive tracers that move through the bloodstream and accumulate in different locations and concentrations in the brain, over time, as different parts of the brain increase and decrease activity (such as glucose metabolism) that is associated with brain function. (A similar technique, known as SPECT, uses single photon emission computed tomography.)

EEG and MEG, short for electroencephalography and magnetoencephalography respectively, record electromagnetic fluctuations in various parts of the brain, as the brain is functioning, using non-invasive sensors applied to the scalp.¹⁸ In research laboratories, the EEG signals can be analyzed in relation to stimuli or responses to obtain *event-related potentials* (ERP), which were used before brain imaging was developed to

make inferences about the brain processes underlying perceptual, cognitive, and motor processes.¹⁹

fMRI (functional magnetic resonance imaging²⁰) uses the technology of regular magnetic resonance imaging adapted to detect changes in hemodynamic (literally “blood movement”) properties of the brain occurring when the subject is engaged in very specific mental tasks. In a nutshell (and with a reminder that we are over-simplifying for heuristic purposes) here’s how it works.

At its most basic, fMRI can be understood as a tool for learning which regions of the brain are working, how much, and for how long, during particular tasks. In much the same way that the body delivers more oxygen to muscles that are working harder, the body delivers more oxygen to brain regions that work harder. The fMRI technique measures blood oxygenation levels—within small cubic volumes of brain tissue known as “voxels”—as those levels change across time with the varying metabolic demands of active neurons.²¹ Changes in demand for oxygen are widely considered to be reliable proxies for inferring the fluctuating activity of the underlying neural tissue.²²

The physical principles underlying fMRI are quite complex. But in general terms the technology works as follows: An fMRI machine creates and manipulates a primary magnetic field,²³ as well as several smaller magnetic fields (one in each three-dimensional plane) that can be quickly varied in orientation and uniformity. Recall (from basic physics) that protons within the nuclei of atoms spin on an axis and carry a positive charge. As they spin, these electric charges form what can be thought of as tiny magnets. When a person is inserted (typically horizontally) into the open bore of an fMRI machine, the previously random axes of spin, for many protons, align, like iron filings along a magnet. That is, the axes begin to point in the same direction. Researchers then administer to the subject’s head brief radio frequency pulses (which usually originate from a device looking rather like a small birdcage that surrounds the subject’s head). Those pulses deflect the protons’ axes of spin temporarily. When the pulses stop, the axes gradually return to their original orientation, releasing energy during that “relaxation” process. The machine can detect characteristics of the released energy because it depends on a proton’s “local” magnetic environment, and this environment is affected by the relative concentrations of oxygenated and deoxygenated blood in local brain tissue. Crucially, as these concentrations are affected by regional changes in brain activity, they provide indirect markers of neural activity that form the basis of the fMRI signal. The machine enables localization

18. This signal is used in conjunction with measures like heart rate and skin electrical conductance to constitute the polygraph procedure that is used commonly in a context of detecting deception. Although used commonly by the U.S. government and police departments, the fundamental limitations of these procedures have been thoroughly described. See, e.g., COMM. TO REVIEW THE SCIENTIFIC EVIDENCE ON THE POLYGRAPH, NAT’L RESEARCH COUNCIL, THE POLYGRAPH AND LIE DETECTION (2003).

19. STEVEN J. LUCK, AN INTRODUCTION TO THE EVENT-RELATED POTENTIAL TECHNIQUE (2005). Some have attempted to use ERP signals in legal settings, but the limitations of this approach are well known and can serve as lessons for the interpretation of brain-imaging

information.

20. The leading “f” remains lowercase, by convention.

21. See generally HUETTEL ET AL., *supra* note 16.

22. There are varying opinions in the neuroscience community about how conclusive an understanding there is of the fMRI signal’s relationship to the activity of neurons, and about how much fMRI can reveal—beyond where brain activation occurred—about behavior and mental states. See, e.g., Logothetis, *supra* note 17; Poldrack et al., *supra* note 17.

23. Magnetic fields are described in Tesla units. A 3-Tesla machine (which uses super-cooled electrical coils) generates a magnetic field roughly 60,000 times the magnetic field of the Earth.

of these signals in space—*i.e.* “spatial resolution”—by collecting them from many different “slices” of the brain. And the technique enables localization of these signals in time—*i.e.*, “temporal resolution”—by recording the signals many times over a period of several seconds for each mental event. A “stack” of slices comprising the whole brain is acquired every couple of seconds or so, enabling the rapid collection of many of these three-dimensional “volumes” of brain activity over the period of an experimental paradigm.

II. KEY CONCEPTS AND GUIDELINES

This part is divided into four sections. These address the legal context, the biological context, the intersection of law and biology, and finally, with that preparatory background, the brain-imaging context. We proceed in this way because one cannot gain a clear understanding of brain imaging, and its intersection with the legal system, without first considering the underlying legal and biological contexts, and their background interactions.

A. THE LEGAL CONTEXT

With terrific, new, whiz-bang technology—which can reveal inner structures and workings of the brain—it is all too tempting to jump past the more mundane legal issues, and to race to apply new techniques to solve new problems in new ways.

But hold the horses. Although our principal purpose here is to discuss how to read (and not read) brain-imaging evidence, we would be remiss not to first anchor the discussion in the legal contexts in which those images might, arguably, be admissible. The territory here is broad, and could occupy us for some time. But to be brief, there are a variety of questions to keep in mind at the outset in order to understand the specific legal context in which brain imaging might be considered in the courtroom.

The threshold consideration, of course, is: *Are the proffered brain images relevant?* Because behavior comes from the brain, and the legal system often cares not only about how someone acted but also why, it is tempting to assume that brain images of people important to the litigation will provide legally relevant information, of one sort or another. But this is, in fact, not a decision to reach lightly.

What specific legal questions do the images purportedly address? Contexts vary considerably, even within the civil and criminal halves of the docket (each of which bears differing underlying standards of proof). Within civil cases, for example, there are a wide variety of different legal purposes into which brain images might conceivably plug. Are brain images proffered to help establish liability, such as in the case of a medical malpractice action? To demonstrate a pre-existing condition, such as in the case of a dispute over insurance coverage? To help estimate damages, such as in the case of a car accident? And within criminal cases, are brain images proffered during

the liability phase, in an effort to defeat the prosecution’s claim that the defendant had (and was therefore capable of having) the mental state requisite for conviction? Are they instead proffered during the sentencing phase, in an effort to mitigate penalty? Are they proffered as evidence of lying or truthfulness?

It is important to remember that the admissibility of brain images is not simply a matter of whether they are scientifically sound. The potential relevance and hence admissibility of brain images will vary, according to *the specific legal issue at hand* within civil and criminal contexts. Put another way, the admissibility of brain images depends largely on their perceived potential relevance (if any) to the issue to be determined, *independent of* (and often before) considering the quality and interpretation of the specific images themselves.

What, specifically, do the images allegedly demonstrate, and how well does that connect to the legal issues at hand? Some of the many variables that may come into play here include: Are these structural or functional images? When were they taken? (For example, before or after events in question?) How recently? Under what circumstances were they procured? (For example, what specific mental tasks was the subject executing during functional imaging?) What is being compared to what? (For example: Are these before and after images of the same brain? Are these comparisons between a party’s brain and a group-averaged composite, for contrast?)

What are the applicable standards for the admissibility of scientific evidence? As is well known, the federal and state systems can have (and often do have) different standards for the admission of scientific evidence. And the state standards vary among the states. It is therefore necessary to note that the backdrop of all that follows below is the specific legal regime under which images are to be evaluated for potential relevance, within the specific context of the specific matters in dispute. Although it is not our purpose here to explore the applicability of scientific-evidence law to brain images, we would be remiss not to flag the centrality of evidentiary rules and contexts to all that follows. Interested readers will find comprehensive discussion of scientific evidence generally in the treatise *MODERN SCIENTIFIC EVIDENCE*.²⁴

B. THE BIOLOGICAL CONTEXT

Understanding the potential relevance of brain images to law also requires a few words of general background about the relationship between biology and behavior generally. Key things to keep in mind (generally speaking) include:²⁵

“[A]dmissibility of brain images is not simply a matter of whether they are scientifically sound.”

24. *MODERN SCIENTIFIC EVIDENCE: THE LAW AND SCIENCE OF EXPERT TESTIMONY* (David L. Faigman et al., eds., 2006). Chapter One provides an excellent overview of the “general acceptance” and validity tests. It examines the cases that established those tests and discusses subsequent cases that applied and further developed those tests.

25. Interested readers can find further information about these background principles in a variety of sources (as well as in the citations that they, in turn, provide). See, e.g., Jeffrey D. Schall, *On Building a Bridge Between Brain and Behavior*, 55 *ANN. REV. PSYCH.* 23 (2004).

“Like the rest of behavior, both criminal and law-abiding behavior originates in the brain.”

- All behavior results from the interaction of genes, environments (including social contexts), developmental history, and the evolutionary processes that built the brain to function in the ways it does.
 - Behavior originates in the physical and chemical activities of the brain.²⁶
 - All behavior is thus “biological.”
- Understanding behavior as biological in nature does not mean that behavior is “biologically determined” in a reductionist or reliably predictive way.
 - The brain is an evolved information-processing organ that, generally speaking, and through differing processes, associates various environmental inputs with various behavioral outputs.
 - Those environmental influences are (generally speaking) unique for each individual.
 - Each person’s brain, though highly flexible, is both anatomically and functionally specialized. (That is, brains do not consist of undifferentiated all-purpose tissue.)
 - Humans share, across the species, a common brain plan of anatomical and functional specialization.
 - Each brain is slightly different in size, shape, and other anatomical features.
 - One area of the brain can affect multiple behaviors.
 - A given behavior arises from multiple areas of the brain.
 - Different individuals can use different parts of the brain, in different ways, on the same cognitive tasks.
 - Behavior is a complex phenomenon, neither attributable to single causes, nor easily parsed among multiple causes.
 - Cognitive phenomena rarely originate from a single region in the brain.

C. THE INTERSECTIONS OF BIOLOGY AND LAW

The potential relevance of brain imaging to law must be evaluated against the broader background of the intersections of law and human biology (both structural and behavioral) generally.²⁷

- Like the rest of behavior, both criminal and law-abiding behavior originates in the brain.
- There is no brain structure, or set of brain structures, that is specifically “for” criminal or law-abiding behavior (since those categorizations of behavior are socially determined).
- To say that brain features influence behavior relevant to crime does not mean that brain features can necessarily explain why certain individuals behaved criminally.

- No explanation of any kind, brain-based or otherwise, has an automatic bearing on justification or exculpation or mitigation in law.
- Legal responsibility for behavior is a legal conclusion, not a scientific finding.
- Establishing a “biological basis” for behavior carries no automatic, normative relevance to anything (legal or otherwise).
- Norms, though influenced by biology, can never be justified by biology alone.

D. THE BRAIN-IMAGING CONTEXT (USING FMRI)

With that brief but foundational background, drawing attention to the legal and biological contexts, and to their interaction, we can now turn to discuss key concepts about brain imaging that judges should know:²⁸

1. Anatomical imaging and functional imaging are importantly different.

Two anatomical images, taken one minute apart, will ordinarily look identical. Yet two functional images, from data collected one minute apart, could look completely different. One reason this is so is simply that, in the latter case, brain activity changes rapidly. Another reason is because fMRI brain images are built statistically, not recorded photographically. In the typical fMRI case, hundreds of recordings are made of each voxel in the brain, at slightly different times (e.g., every two seconds). Each recording of each voxel within a given trial is analogous to a single frame in a movie. Learning what happens within each voxel, over time, is akin to watching motion seem to emerge from the successive snapshots that comprise a moving picture. But that metaphor only captures part of the fMRI technique, because there are subsequently many repeat recordings of that voxel, under similar conditions, on many consecutive trials—the results of which are typically then averaged across trials. Complicating matters further is that there are about 100,000 voxels within the brain, and what typically matters is how neural activity within those voxels is varying over time, in relation to some task a subject undertakes while being scanned. Furthermore, within each voxel are millions of neurons of different types, interacting in ways that could be mechanistically different but indistinguishable from the measure of fMRI. In the end, fMRI brain images lay the result of any one of many possible statistical tests overtop of an anatomical image of a selected slice of the brain. That is, an fMRI image is a composite of an anatomical image, of the researcher’s choosing, and a statistical representation of the brain activity in that image, also of the researcher’s choosing.

2. Functional brain imaging is not mind reading.

There is more to a thought than blood flow and oxygen.

26. Yes, the alert reader will point out that some behavior, such as reflexes, leaps right out of the spinal cord. In the text, we are speaking in generalities.

27. See, e.g., Owen D. Jones & Timothy H. Goldsmith, *Law and Behavioral Biology*, 105 COLUM. L. REV. 405 (2005). See also LAW & THE BRAIN (Semir Zeki & Oliver Goodenough, eds., 2006); LAW, MIND, AND BRAIN (Michael Freeman & Oliver Goodenough, eds., 2009);

THE IMPACT OF BEHAVIORAL SCIENCES ON CRIMINAL LAW (Nita Farahany ed., 2009); Owen D. Jones, *Behavioral Genetics and Crime, in Context*, 69 L. & CONTEMP. PROBLEMS 81 (2006); bibliographic sources compiled on the website of *The Society for Evolutionary Analysis in Law* (www.sealsite.org).

28. For more details, see sources cited *supra* note 16.

fMRI is very good at discovering where brain tissue is active (commonly by highlighting differences between brain activations during different cognitive tasks). But differences are not thoughts. fMRI can show differences in brain activation across locations, across time, and across tasks. But that often does not enable any reliable conclusion about precisely what a person is thinking.²⁹

3. Scanners don't create fMRI brain images; people create fMRI brain images.

Images are only as good as the manner in which the researcher designed the specific task or experiment, deployed the machine, collected the data, analyzed the results, and generated the images. It is important to remember that fMRI images are the result of a process about a process. Multiple choices and multiple steps go into determining exactly what data will be collected, how, and when—as well as into how the data will be analyzed and how it will be presented.

4. Group-averaged and individual brain images are importantly different.

Most brain-imaging research is directed toward understanding how *the average brain*, within a subject population, is activated during different tasks. This is not at all the same thing as saying either that all brains performing the same task activate in the average way, or saying that the activation of a single brain can tell us anything meaningful about the operation of the average brain. Consequently:

Do not assume that the scan of any individual is necessarily representative of any group.

Do not assume that the averaged scan of any group will necessarily be representative of any individual.

5. There is no inherent meaning to the color on an fMRI brain image.

fMRI does not detect colors in the brain. fMRI images use colors—of whatever segment of the rainbow the researcher prefers—to signify *the result of a statistical test*. By convention, the brighter the color (say, yellow compared to orange) the greater the statistical significance of the differences in brain activity between two conditions. Put another way, the brighter the color, the less likely it is that the differences in brain activity in that voxel or region, between two different cognitive tasks, was due to chance alone. As with any color-coded representation, accurate interpretation requires knowing exactly what each color represents in absolute terms. The researcher specifies what each color will represent, and this matters. Yellow might mean that there is only one chance in 1,000 that the

difference between brain activations in this voxel, between conditions, is due to random chance. Or, yellow might mean that there is one chance in 20 that the difference is due to random chance.³⁰

6. fMRI brain images do not speak for themselves.

No fMRI brain image has automatic, self-evident significance. Even well-designed, well-executed, properly analyzed, properly generated images must have their import, in context, interpreted.

7. Classification of an anatomical or behavioral feature of the brain as normal or abnormal is not a simple thing.

Because we have learned a great deal about the brain, from dissection, imaging, and the like, we have some confidence about what a typical brain looks like, and how a typical brain functions. But even without full anatomical scans of everyone on the planet, we know there is considerable variation—both anatomically and functionally—within some general parameters. That means that it can be (with some exceptions, such as a bullet lodged in the brain) difficult to say with precision *how* uncommon a given feature or functional pattern may be, even if it appears to be atypical. Base rates for anatomical or functional conditions are often unknown. For example: suppose brain images show that a defendant has an abnormal brain feature. We often do not have any idea how many people with nearly identical abnormalities do not behave as the defendant did. How, then, to make a reasonable conclusion about the causal effect of the brain condition?

8. Even when an atypical feature of function is identified, understanding the meaning of that is considerably complex.

Brain images can show unique features and functions of a person's brain. But the meaning of them is rarely self-evident. Determining which of those are important, and how, depends not only on the legal context for which the images are offered, but also on expert analysis of what the images do and do not mean. For example, suppose that measurement of the fMRI-detected signal during a given cognitive task indicates that a person has less neural activity in a given region than the average person. Does that mean that the person is somehow cognitively impaired in that region? Or might it alternatively indicate that the person has more expertise or experience than

“[W]e have some confidence about what a typical brain looks like, and how a typical brain functions.”

29. There appear to be some exceptions. See, e.g., John-Dylan Haynes et al., *Reading Hidden Intentions in the Human Brain*, 17 CURRENT BIOLOGY 323 (2007) (determining through brain imaging, with up to 71% accuracy, which of two tasks a person is covertly intending to perform); Y. Kamitani & F. Tong, *Decoding the Visual and Subjective Contents of the Human Brain*, 8 NATURE NEUROSCIENCE 679 (2005) (determining through brain imaging, with near 80% accuracy, which of two overlapping visual patterns a person is paying attention to); S. A. Harrison & F. Tong, *Decoding Reveals the Contents of Visual Working Memory in Early Visual Areas*, 458 NATURE 632–35 (2009) (determining through brain imaging, with 83–86% accuracy, which of two visual patterns a person is actively maintaining in memory).

30. Consider this quote from a popular account:

With PET, for example, a depressed brain will show up in cold, brain-inactive deep blues, dark purples, and hunter greens; the same brain when hypomanic however, is lit up like a Christmas tree, with vivid patches of bright reds and yellows and oranges. Never has the color and structure of science so completely captured the cold inward deadness of depression or the vibrant, active engagement of mania.
KAY REDFIELD JAMISON, *AN UNQUIET MIND: A MEMOIR OF MOODS AND MADNESS* 196 (1995). Our point here is that the colors used are arbitrary, and may have been represented in this way to create precisely this impression.

“[T]he issues for the legal system are simply the same as they long have been: What might the proffered evidence tell us . . . ?”

average, requiring less cognitive effort?

9. Correlation is (still) not causation.

The fact that two things vary in parallel tells us little about whether the two are necessarily causally related and, if so, which causes which. For example, suppose brain imaging reveals that 70% of inmates on death row for homicide have atypical brain activation in a given region, compared to normal,

unincarcerated subjects. That statistic does not mean that the brain activation pattern causes homicidal behavior. It might mean that having murdered affects brain activations, or that being incarcerated for long periods of time affects brain activations, or something else entirely.

10. Today's brain is not yesterday's brain.

In all but the most fanciful of contexts, a brain scan likely takes place long after the behavior (such as criminal activity) that gives rise to the scan. Drawing causal inferences is therefore further complicated. People's brains change with age and experience. And some proportion of the population will develop atypical anatomical or functional conditions over time. If a defendant is scanned six months or six years after the act in question, and the scan detects an abnormality, it is not a simple matter to conclude with confidence that the same abnormality was present at the time in question or—even if one assumes so, *arguendo*—that it would have meaningfully affected behavior.

11. Scanners (in theory) detect what they are built, programmed, and instructed to detect, in the way they are built, programmed, and instructed to detect it.

Scanners are highly complex and often unique pieces of machinery. So (as in other areas of science) are the people who calibrate, program, operate, and interpret collected data. It is important to recognize that the product of these intersecting complexities may or may not be reliable, generalizable, and replicable.

12. fMRI brain imaging enables inferences about the mind, built on inferences about neural activity, built on the detection of physiological functions believed to be reliably associated with brain activity.

It is important to remember that fMRI does not provide a

direct measure of neuronal activity—as do, for example, invasive techniques that measure single neuron recordings. fMRI detects fluctuations in oxygen concentrations thought to be reliably associated with neuronal activity. But the precise relationship between metabolic demands and neuronal function remains poorly understood.

Even if regional activations in brain images reflect true neural activity, it should also be kept in mind that our ability to confidently infer the cognitive process that must have led to such regional activation is highly constrained. This is because neuroscientists still understand so little about what the various regions of the human brain contribute to a particular cognitive function.

CONCLUSION

We have provided above a very brief introduction to the intersection of brain imaging and law principally intended for those judges relatively new to this interdisciplinary intersection. This article also provides some scientific context for the other articles in this special issue of *Court Review*.

As reflected in the numerous citations and descriptions of neuroscience matters in the other articles in the special issue, courts are already frequently confronted with issues concerning the admissibility and proper interpretation of brain images. And all present indicators suggest that brain images will be proffered by more lawyers in more cases in more contexts for more purposes in the future.

On one hand, the issues for the legal system are simply the same as they long have been: What might the proffered evidence tell us that may help us to answer legally identified questions in fair, effective, and efficient ways? Brain imaging is simply the latest high-tech tool to be offered for its potential assistance in this age-old enterprise.

On the other hand, brain imaging represents a perfect storm of power, to be used or abused. It combines the authoritative patina enjoyed by scientific evidence generally, and the allure of all-modern brain science specifically, with the seductive power of visual images.

How the legal system will ultimately deal with the exogenous shock of such technologically, rhetorically, and visually powerful information remains to be seen. To deal with it well, however, the legal system will need the combined efforts and advice of many legal and neuroscientific scholars,³¹ such as those populating the MacArthur Foundation Research Network

31. See, e.g., LAW AND THE BRAIN (Semir Zeki & Oliver Goodenough, eds., 2006); LAW, MIND, AND BRAIN (Michael Freeman & Oliver R. Goodenough eds., 2009); NEUROSCIENCE AND THE LAW: BRAIN, MIND, AND THE SCALES OF JUSTICE (Brent Garland ed., 2004); George J. Annas, *Foreword: Imagining a New Era of Neuroimaging, Neuroethics, and Neurolaw*, 33 AM. J.L. & MED. 163 (2007); Bruce A. Arrigo, *Punishment, Freedom, and the Culture of Control: The Case of Brain Imaging and the Law*, 33 AM. J.L. & MED. 457 (2007); Abram S. Barth, Note and Comment, *A Double-Edged Sword: The Role of Neuroimaging in Federal Capital Sentencing*, 33 AM. J.L. & MED. 501 (2007); Nita Farahany, *Cruel and Unequal Punishments*, 86 WASH. U. L.R. 859 (2009); Neal Feigenson, *Brain Imaging and Courtroom Evidence: On the Admissibility and Persuasiveness of fMRI*, 2 INT'L J. L. CONTEXT 233 (2006); Brent Garland & Paul W. Glimcher, *Cog-*

nitive Neuroscience and the Law, 16 CURRENT OPINION IN NEUROBIOLOGY 130 (2006); Steven Goldberg, *MRIs and the Perception of Risk*, 33 AM. J.L. & MED. 229 (2007); Oliver R. Goodenough, *Mapping Cortical Areas Associated with Legal Reasoning and Moral Intuition*, 41 JURIMETRICS J. 429 (2001); Henry T. Greely, *Neuroscience and Criminal Justice: Not Responsibility but Treatment*, 56 U. KAN. L. REV. 1103 (2008); Henry T. Greely, *Remarks on Human Biological Enhancement*, 56 U. KAN. L. REV. 1139 (2008); Henry T. Greely & Judy Illes, *Neuroscience-Based Lie Detection: The Urgent Need for Regulation*, 33 AM. J.L. & MED. 377 (2007); Joshua Greene & Jonathan Cohen, *For the Law, Neuroscience Changes Nothing and Everything*, 359 PHIL. TRANSACTIONS ROYAL SOC'Y LONDON B: BIOLOGICAL SCI. 1775 (2004); Charles N. W. Keckler, *Cross Examining the Brain: A Legal Analysis of Neural Imaging for Credibility*

on Law and Neuroscience,³² the Gruter Institute for Law and Behavioral Research,³³ and the Society for Evolutionary Analysis in Law (SEAL).³⁴ And, fortunately, many efforts are underway. In the meantime, judges likely to encounter brain images in their work would be well-advised to lay carefully constructed mental templates, on which to hang existing and future information emerging from brain-imaging communities. We hope that what we have discussed here will provide a useful means for doing so.



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PHIL. TRANSACTIONS ROYAL SOC'Y LONDON B: BIOLOGICAL SCI. 1787 (2004); Alexander McCall Smith, *Human Action, Neuroscience, and the Law*, in THE NEW BRAIN SCIENCES: PERILS AND PROSPECTS 103 (Dai Rees & Steven Rose eds., 2004); O. Carter Snead, *Neuroimaging and the "Complexity" of Capital Punishment*, 82 N.Y.U. L. REV. 1265 (2007); Sarah E. Stoller & Paul Root Wolpe, *Emerging Neurotechnologies for Lie Detection and the Fifth Amendment*, 33 AM. J.L. & MED. 359 (2007); 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 (2007); Erich Taylor, Note, *A New Wave of Police Interrogation? "Brain Fingerprinting," the Constitutional Privilege Against Self-Incrimination, and Hearsay Jurisprudence*, 2006 U. ILL. J.L. TECH. & POL'Y 287 (2006); Sean Kevin Thompson, *A Brave New World of Interrogation Jurisprudence?*, 33 AM. J.L. & MED. 341 (2007); Stacey A. Tovino, *Functional Neuroimaging Information: A Case for Neuro Exceptionalism?*, 34 FLA. ST. U. L. REV. 415 (2007); Stacey A. Tovino, *Imaging Body Structure and Mapping Brain Function: A Historical Approach*, 33 AM. J.L. & MED. 193 (2007); Special Issue, *International Perspectives on Brain Imaging and the Law*, 26 BEHAV. SCI. & L. 1 (2008).

32. The MacArthur Foundation Research Network on Law and Neuroscience, <http://www.lawneuro.org>.

33. Gruter Institute, <http://www.gruterinstitute.org>.

34. Society for Evolutionary Analysis in Law, <http://www.sealsite.org>.

Evidentiary Incommensurability:

A Preliminary Exploration of the Problem of Reasoning from General Scientific Data to Individualized Legal Decision-Making

David L. Faigman

Scientists typically study variables at the population level, and most of their methodological and statistical tools are designed for this kind of work. The trial process, in contrast, ordinarily concerns whether a particular case is an instance of the general phenomenon. As I have previously observed, “[w]hile science attempts to discover the universals hiding among the particulars, trial courts attempt to discover the particulars hiding among the universals.”¹ This essential difference in perspective between what scientists normally do and what the trial process is ordinarily about has yet to be studied with any degree of rigor—by scientists or lawyers.² Yet this phenomenon is endemic to virtually every context in which law and science meet. Indeed, it might be said to be the single greatest obstacle to the law’s rational use of science.³

The challenges associated with individualizing science, however, are not unique to the law. In fact, in a wide variety of social contexts, empirical research exploring general phenomena are sought to be applied reliably to individual cases. In medicine, for example, research on the effectiveness of various cancer therapies will inform a particular patient’s decision regarding which therapy to choose. In meteorology, research on hurricanes will inform a governor’s decision regarding

whether to evacuate a particular city. Indeed, all applied science, ranging from aerodynamics to zoology, potentially presents the problem of making decisions about discrete cases based on group data. Different fields have adapted strategies to respond to the evidentiary-incommensurability challenge with differing degrees of success. In medical decision-making, for example, evidence-based medicine is one way that doctors have sought to bring data to bear on individual diagnostic and therapeutic judgments.⁴ Meteorologists generate computer models that describe the likelihoods associated with a storm’s path and strength.⁵ At least from an outsider’s perspective, these efforts have not been so successful that courts would want to borrow them wholesale.⁶

How and whether general data can be usefully employed to inform decisions about individual events is a problem that is central to the law’s function. In fact, courts are generally acquainted with the difficulties inherent in employing general scientific data to reach conclusions about specific cases. The primary area in which courts have considered this matter is in medical causation cases where they distinguish routinely between “general causation” and “specific causation.”⁷ Courts and legal scholars have not, however, engaged in a careful

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Footnotes

1. DAVID L. FAIGMAN, *LEGAL ALCHEMY: THE USE AND MISUSE OF SCIENCE IN THE LAW* 69 (1999).
2. One exception to this yawning silence is the work of Joseph Sanders. See generally Joseph Sanders, *Applying Daubert Inconsistently? Proof of Individual Causation in Toxic Tort and Forensic Cases*, 75 *BROOK. L. REV.* 1367 (2010). In addition, the statistical challenges associated with individualizing group data have been examined with considerable sophistication in the context of predictions of violence. See, e.g., Stephen D. Hart et al., *Precision of Actuarial Risk Assessment Instruments: Evaluating the ‘Margins of Error’ of Group v. Individual Predictions of Violence*, 190 *BRIT. J. PSYCHIATRY* s60 (2007); Douglas Mossman, *Analyzing the Performance of Risk Assessment Instruments: A Response to Vrieze and Grove*, 32 *LAW & HUM. BEHAV.* 279, 280 (2008); Scott I. Vrieze & William M. Grove, *Predicting Sex Offender Recidivism*, 32 *LAW & HUM. BEHAV.* 266, 267 (2008). The problems of individualizing group data have also caught the attention of neuroscientists. See, e.g., Michael B. Miller et al., *Extensive Individual Differences in Brain Activations Associated with Episodic Retrieval Are Reliable over Time*, 14 *J. COGNITIVE NEUROSCIENCE* 1200 (2002). On the issue more generally, see John A. Swets, Robyn M. Dawes & John Monahan, *Better Decisions Through Science*, 283 *SCI. AM.* 82 (2000). Ultimately, however, the question of individualizing group data for courtroom use is not simply a problem of inferential

statistics. See David L. Faigman, *The Limits of Science in the Courtroom*, in *BEYOND COMMON SENSE: PSYCHOLOGICAL SCIENCE IN THE COURTROOM* 303 (Eugene Borgida & Susan T. Fiske eds., 2008).

3. See, e.g., Margaret A. Berger, *Eliminating General Causation: Notes Towards a New Theory of Justice and Toxic Torts*, 97 *COLUM. L. REV.* 2117, 2129–30 (1997); Margaret A. Berger & Lawrence M. Solan, *The Uneasy Relationship Between Science and Law: An Essay and Introduction*, 73 *BROOK. L. REV.* 847, 852–53 (2008).
4. Daniel B. Mark, *Decision-Making in Clinical Medicine*, in 1 *HARRISON’S PRINCIPLES OF INTERNAL MEDICINE* 6, 6 (Dennis L. Kaspar et al. eds., 16th ed. 2005).
5. See, e.g., DAVID J. STENSRUD, *PARAMETERIZATION SCHEMES: KEYS TO UNDERSTANDING NUMERICAL WEATHER PREDICTION MODELS* (2007).
6. For example, Dr. Jerome Groopman cautions against over-reliance on evidence-based medicine, fearing that it “risks having the physician choose [a treatment course] passively, solely by the numbers,” rather than rely on the individual circumstances of each patient. JEROME GROOPMAN, *HOW DOCTORS THINK* 5–6 (2007).
7. See DAVID L. FAIGMAN ET AL., 3 *MODERN SCIENTIFIC EVIDENCE: THE LAW AND SCIENCE OF EXPERT TESTIMONY* § 21:6-7, at 27–45 (2008–2009 ed.) (listing cases). Not all science is engaged in describing cause-and-effect relationships, so “general causation” and “specific causation” are subcategories of what might more properly be labeled “general propositions” and “specific application.” Sometimes general propositions in science will be stated in causative terms, but very often they will be associational, technical, or descriptive. Specific application refers to the determination whether a particular case is an instance, use, or example of general propositions that are supported by research.

study of the details and intricacies associated with this matter across the wide spectrum of cases in which it presents itself. In addition, although the courts are passingly familiar with the problem of evidentiary incommensurability, they naturally approach the subject from their own need for information, with little appreciation for how and whether scientists can produce this information. Courts frequently demand empirical answers despite scientists' inability to provide them.⁸ At the same time, scientists involved in the legal process naturally approach the problem of incommensurability from the perspective of their own desire to produce information, with little appreciation for how and whether the courts can effectively use this information.⁹ It is hardly surprising that scientists should study the questions that they are most curious about and able to answer rather than those the law deems most relevant. In short, therefore, the two sides, law and science, perceive incommensurability from their separate vantage points, which largely perpetuates the problem.

This essay jumps into the center of this conundrum. My objective, however, is somewhat unusual. It is a call to arms. I do not aim to resolve the incommensurability paradox but rather to ring the fire bell. Indeed, given the scope and depth of the obstacles presented by evidentiary incommensurability, it is a subject well beyond resolution in the pages provided to me here. My purpose, then, is to explore the paradox in the hope that it will help lay a common framework through which both lawyers and scientists might understand the challenges presented at the intersection of these two great professions. This essay, therefore, contemplates many of the sundry issues that would have to be reckoned with in any subsequent comprehensive effort to bring systematic rationality to the problem of employing group data to decide individual cases. It is divided into two parts. Part I, Hypothesis Testing in Science, considers scientific hypothesis testing and the inherent population focus of most of that work. While most scientific research focuses on a general population-level analysis, results of that work can have very different levels of probative value in regard to informing decision-making at the individual level. Part II, Framing Empirical Questions in the Courtroom, examines evidentiary demands in the courtroom and the inherent individualized focus of that process. This part also considers some of the challenges inherent in any attempt to close the evidentiary-incommensurability gap between what most science says and what most legal proceedings need to know.

HYPOTHESIS TESTING IN SCIENCE

Scientific research is most often conducted from a general and population-based perspective. This is a defining charac-

8. Among many possible examples that could be cited, possibly the most obvious is that of predicting violence. Courts call upon experts in myriad contexts to predict future behavior, from probation decisions to capital sentencing, though the best empirical research indicates that such expert opinions remain highly fallible. See John Monahan, *A Jurisprudence of Risk Assessment: Forecasting Harm Among Prisoners, Predators, and Patients*, 92 VA. L. REV. 391, 405–07 (2006).

teristic of the field. However, scientific methods, and the phenomena that scientists study, range widely. Inevitably, the demands of the empirical context dictate which set of research designs are, or might be, available. While studying the effects of depleted biodiversity in the Amazon rainforest and investigating the interaction between neuron and glial cells in a rat's brain are both scientific endeavors, the methods involved are obviously disparate. Yet, from the law's perspective, there may be certain insights that persist across scientific domains in regard to individualizing group data. This section provides a preliminary sketch of the scientific landscape and examines whether certain common denominators might be identified within the process of bringing group data to bear on individual decisions.

The essential question posed in the context of reasoning from the group to the individual is whether a particular case is an instance of the general phenomenon. If smoking causes lung cancer, the individualized query is whether a particular person's lung cancer was caused by smoking. The degree to which scientific research might be relevant to resolving an individualized question varies from completely to not-at-all relevant. In some areas, science might provide a definitive answer to the question of whether an individual case is an instance of a general phenomenon. If tobacco smoke is the only cause of lung cancer, we logically know that someone with lung cancer got sick from tobacco smoke. In other areas, science might help increase the accuracy of individual decision-making along a range of helpfulness, from nearly deterministic to just above random chance. If tobacco smoke causes lung cancer, but many other things, known and unknown, do so as well, we cannot say with certainty that the person's lung cancer was caused by tobacco smoke. The degree of certainty that the science provides, of course, is the operative question. Indeed, sometimes even very good science will not demonstrably improve the accuracy of individual decision-making, though it might nonetheless be relevant and admissible in court because it provides the triers of fact with contextual information that will help them understand other evidence in the case.

WHEN GENERAL SCIENCE IS DETERMINATIVE IN PARTICULAR CASES

In practice, the law is interested not simply in whether a particular variable causes a particular effect, but, ultimately, in

9. Scientists do not generally study how to "individualize" their findings in ways that would make their findings more helpful for legal usage. This is not meant as a criticism, only an observation. Especially in the social sciences, it is ordinarily sufficient to find a statistically significant effect among college sophomores. Little attention has been paid to how the variables studied might operate in a particular case.

"The essential question . . . is whether a particular case is an instance of the general phenomenon."

“In some situations, the science will be nearly definitive regarding a specific cause-and-effect relation. . . .”

whether a particular variable did cause the effect.¹⁰ Scientific research will sometimes identify a single unidirectional relationship between two variables. In medicine, the term *pathognomonic* refers to a diagnostic version of this insight. A symptom is pathognomonic when it is “decisively characteristic of a disease.”¹¹ For example, “Koplik’s spots are pathognomonic of measles.”¹² The strongest version

of a path-specific relationship would be the unusual situation where a cause and an effect are uniquely associated, such that the cause always produces the effect and the effect is always attributable to the cause. Outside of basic physics and chemistry, however, the strongest version of path-specificity will be quite rare. Nonetheless, such relationships are possible. This strong version could be termed *cause/effect path-specificity* because the cause and the effect are uniquely tied to one another.

The law is also interested in weaker versions of path-specificity. For instance, a particular cause might always produce a particular effect, but other causes might produce similar effects. This could be termed *causal path-specificity* because the cause always produces a single effect, but other causes might produce the same effect. An example of this might be a lesion in a specific part of the brain that produces auditory hallucinations. Anyone with such a lesion would suffer from auditory hallucinations, but not all people with auditory hallucinations have a lesion in that region of the brain. Conversely, a particular effect might always be produced by a particular cause, but the cause does not invariably produce the effect. This could be termed *effect path-specificity* because the effect has a single cause, but the cause does not have a single effect. An example of this is the relationship between asbestos exposure and mesothelioma. The unique cause of mesothelioma is exposure to asbestos, but not everyone exposed to asbestos develops mesothelioma.¹³

In legal proceedings, the strength and nature of path-specificity is likely to be important. In general, *cause/effect path-specificity* will be the most probative kind of scientific evidence available. In contrast, the probative power of *causal path-specificity* or *effect path-specificity* will depend on the substantive law of the case. For example, in many criminal cases, the issue will be whether the defendant suffered the relevant effect, and it will not matter greatly that a variety of causes can produce it. In such cases, scientific evidence of

causal path-specificity would strongly support the defendant’s case. This would be so in an insanity case in which evidence that the defendant has a brain lesion that invariably produces auditory hallucinations would be highly probative, despite the fact that other factors might cause the same symptoms. Conversely, in many civil cases, *effect path-specificity* will be the more probative kind of evidence. In the example of mesothelioma, a civil plaintiff who has this disease will be able to trace it back to asbestos exposure. In many civil cases, a substantial obstacle to a plaintiff’s recovery is showing that the effect he or she suffers from is attributable to a cause associated with the defendant. *Effect path-specificity* solves this difficulty. If the defendant was responsible for the plaintiff’s asbestos exposure, then the plaintiff’s mesothelioma is attributable to the defendant.

WHEN GENERAL SCIENCE IS PROBATIVE, BUT NOT DETERMINATIVE, IN PARTICULAR CASES

In most applied-science contexts, path-specificity is not possible, either because it does not exist in actuality or because scientists’ methods are unable to identify it in those cases in which it does exist. In most areas of interest to the law, scientific research provides knowledge about *cause-and-effect relationships* generally, but will be only more or less determinate on the question of whether a specific instance of an effect is attributable to a specific cause, or that a specific cause contributed to a particular effect. In this vast domain, applied scientific research comes in myriad forms, and its value for deciding individual cases varies greatly. In some situations, the science will be nearly definitive regarding a specific *cause-and-effect relation*, and in others it will do little more than increase the likelihood slightly above chance that a relevant relationship exists.

As is true with the concept of path-specificity discussed in the previous section, indeterminate scientific research might be relevant in legal proceedings in three separately identifiable ways, regarding (1) *effect only*, because the cause is known (or can be assumed); (2) *cause only*, because the effect is known (or can be assumed); or (3) *both cause and effect*. As will become clear in the discussion that follows, the intended purpose for which the science is to be used is associated with the demands that courts place on the science itself.

In many legal contexts, only the effect is relevant because the causal variable is fairly known or is assumed. Indeed, one of the best-known subjects in law and psychology fits this category: *eyewitness identification*. In *eyewitness-identification* research, researchers have found that certain factors interfere with accuracy, such as presence of a weapon, cross-race identifications, and use of leading questions by interviewers.¹⁴ In

10. This analysis simplifies matters considerably, since both the existence and extent of the cause, as well as the existence and extent of the effect, may be disputed in a particular case.

11. MONDOFACTO ONLINE MEDICAL DICTIONARY, PATHOGNOMONIC, <http://www.mondofacto.com/facts/dictionary?pathognomonic> (last visited Nov. 5, 2013).

12. MEDICINET, DEFINITION OF PATHOGNOMONIC, <http://www.medterms.com/script/main/art.asp?articlekey=6386> (last visited Nov.

5, 2013).

13. Asbestos also causes other ailments, including lung cancer. See Piero Mustacchi, *Lung Cancer Latency and Asbestos Liability*, 17 J. LEGAL MED. 277, 280 (1996). But, as mentioned, some people who are exposed to asbestos never get sick from it.

14. See Gary L. Wells, *Eyewitness Identification: Scientific Status*, in 2 MODERN SCIENTIFIC EVIDENCE: THE LAW AND SCIENCE OF EXPERT TESTIMONY, *supra* note 7, at 520, 534–47.

this example, the causal side of the equation is the independent variable, which is more or less known or assumed to be present in the case. The focus, therefore, is principally on what effect this causal variable has had. Hence, if the witness is white and the perpetrator is black, the empirical crux of the matter concerns what effect this causal variable has on the accuracy of the identification. Other examples in which the effects are relevant and the cause is known or assumed include the effects of hypnosis on memory,¹⁵ the impact of putatively prejudicial photographs or images on fact-finders' judgments,¹⁶ and the effect of violent television on viewers.¹⁷

In effect-relevant cases—that is, where the cause is known or assumed and the effects have been the subject of research—the science is rarely employed to do more than provide general insights about those who have experienced the causal variable of interest. It may very well be, for instance, that when a gun is present, eyewitness identifications are on average less accurate than when one is not; but this finding provides very little information regarding whether any particular identification is accurate. In the law, general research findings might very well be relevant and admissible to inform the jury of factors that might interfere with a witness's accurate recall, which the jury could use or ignore as it deemed fit. The science in this case, however, says very little about eyewitness identification.

The second category, and one that arises often in court, is when the effect is fairly known (or can be assumed), and the science is offered to demonstrate the cause of that effect. Whole areas of medical and psychological causation fit this category, as do some areas of forensic science. In medical causation, a plaintiff might be known to have leukemia (*i.e.*, the effect) and the scientifically controverted issue will be whether one variable (*e.g.*, trichloroethylene) or another caused the illness. In psychological causation, the same analysis applies. For example, a witness who suffers from post-traumatic stress disorder (PTSD) might claim that it was caused by a sexual assault rather than other causes, such as a failed marriage and a lost job. Finally, some areas of forensic science fit this cause-relevant category. The best example is arson investigation. In the ordinary arson case, the effect is known (*i.e.*, a burned or exploded structure), but the science is offered to demonstrate the cause (*e.g.*, purposely set using some incendiary device or material).

When the proffered science is relevant to determining the cause of some known effect, it is ultimately meant to operate diagnostically in regard to the individual case at hand. This category presents the most classic manifestation of the chal-

lenges associated with applying reasoning from group data to decisions in individual cases. In many areas, the research provides substantial evidence of a general connection between variables, but the science does not pave a direct path for extrapolating general data to apply to the individual case. Ordinarily, some additional method is used to bring the general science to the individual case, usually labeled vaguely as “differential diagnosis” or “differential etiology.”¹⁸ This issue is considered in Part II, *infra*.

“[T]he methods of science do not correspond neatly to the needs of the law.”

The third and final category of scientific relevance is something of a catch-all and involves those cases in which the science informs both the cause and the effect sides of the equation. In other words, in this category the situation or context is argued to have legal significance, but the science is necessary to show how or why this is so. Many psychological claims fall into this category, as do most forensic identification technologies. A good example of the former is research on predictions of violence. The matter of predicting violence has wide significance in the law, and scientists have sought to provide guidance on this issue by relating one set of variables (*i.e.*, predictors) to another variable (*i.e.*, future violence). Neither the “cause” nor the “effect” is known outside of the applicable research. Most forensic-identification technologies operate similarly. Scientific research on DNA profiling, for instance, describes both the existence of the phenomenon as well as the significance of that phenomenon for legal decision-making. Significantly, both actuarial predictions of violence and DNA profiling are framed generally, and, to the extent that they are applied to individual cases, the proffered opinions ordinarily remain in their general population-based form.¹⁹

In the end, law and science are separate disciplines and, though they often share goals or objectives, neither is nor should be expected to be the other's handmaiden. It is hardly surprising, therefore, that the methods of science do not correspond neatly to the needs of the law. Yet, at least in a preliminary way, it is possible to identify general pathways of scientific investigation and consider how they sometimes might, but oftentimes do not, provide the answers to the questions the law poses. Understanding the parameters of the scientific enterprise, however, is only the first step in improving the law's use of research data. Much of the information the law needs from science does not fit neatly into conventional modes of empirical inquiry. Whereas scientists ordinarily study causes

15. See Michael Nash & Robert Nadon, *Hypnosis: Scientific Status*, in 2 MODERN SCIENTIFIC EVIDENCE: THE LAW AND SCIENCE OF EXPERT TESTIMONY, *supra* note 7, at 733.
16. David A. Bright & Jane Goodman-Delahunty, *Gruesome Evidence and Emotion: Anger, Blame, and Jury Decision-Making*, 30 LAW & HUM. BEHAV. 183 (2006).
17. Kevin D. Browne & Catherine Hamilton-Giachritsis, *The Influence of Violent Media on Children and Adolescents: A Public-Health Approach*, 365 LANCET 702, 702 (2005).
18. See generally FAIGMAN ET AL., *supra* note 7, at 27–49.
19. See Helena Kraemer et al., *Coming to Terms With the Terms of Risk*,

54 ARCHIVE GEN. PSYCHIATRY 337, 340 (1997). It should be noted that, very often, an expert witness's predictions of violence are not based on scientific research at all. Many, if not most, opinions offered in court on this subject are based on clinical judgment, and they are presented accordingly as conclusions about a particular person. On the value of clinical versus actuarial predictions of violence, see Stefania Aegisdottir, *The Meta-Analysis of Clinical Judgment Project: Fifty-Six Years of Accumulated Research on Clinical Versus Actuarial Predictions of Violence*, 34 COUNSELING PSYCHOLOGIST 400 (2006).

**“Professor
Kenneth Culp
Davis. . .
distinguished
between. . .
legislative facts
and adjudicative
facts.”**

and effects in populations, courts ordinarily need to determine causes and effects in particular individuals. The next section examines the difficulties endemic to developing a rigorous individual-based empiricism.

FRAMING EMPIRICAL QUESTIONS IN THE COURTROOM

The basic perspective of most courtroom proceedings is individual and specific. Courts look to

answer such questions as whether the defendant killed the victim, the plaintiff’s leukemia was caused by a chemical produced by the defendant, the juvenile defendant is competent to be tried as an adult, the capital defendant is likely to be violent if not executed, and so forth. While the ultimate issue in most legal proceedings involves the determination of a particular fact (or facts), courts well understand that underlying these specific questions is knowledge about the general world. Hence, a defendant’s guilt might depend on the general match probabilities of DNA evidence, and a plaintiff’s civil claim against a chemical manufacturer might depend partly on epidemiological studies showing an association between the alleged offending chemical and leukemia. Tackling the complex challenge of integrating scientific research into legal decision-making would be helped considerably if there were a vocabulary that permitted categorization of the different ways science might be relevant to legal decision-making. There has been no shortage of attempts at providing such a taxonomy.²⁰

TAXONOMIES OF FACT-FINDING

The first, and still most influential, taxonomy of fact-finding in law was offered by Professor Kenneth Culp Davis.²¹ Davis distinguished between what he termed legislative facts and adjudicative facts. Legislative facts are those facts that transcend the particular dispute and are relevant to legal reasoning and the fashioning of legal rules.²² Adjudicative facts, in contrast, are those facts particular to the dispute.²³

In a series of influential articles in the 1980s, Professors John Monahan and Laurens Walker refined Davis’s dichotomy

in a manner that more fully captures the ways that science is used in the courtroom.²⁴ Their primary focus was on the law’s use of social science. They identified three levels of convergence between social science and law: social authority, social facts, and social frameworks. Social authority refers to social science research relevant to the determination of legislative facts and thus the formulation of legal rules.²⁵ According to their proposal, social authority is analogous to legal authority and should be consulted similarly. Hence, judges would consider social science “precedent” (*i.e.*, past research) as presented through briefs, arguments, and *sua sponte*.²⁶ The information found to be relevant and valid would then be incorporated into the judge’s conclusions of law. Alternatively, in the Monahan-Walker model, social science research might be relevant to adjudicative facts (what they call “social facts”), in which case, after being deemed admissible, it would be presented to the trier of fact through expert testimony.²⁷ Finally, social science research might have relevance as a combination of social authority and adjudicative fact. Professors Monahan and Walker label this use “social frameworks,” where some issue in the particular dispute is claimed to be an instance of a social scientific finding or theory of general import.²⁸

The Monahan-Walker model, though framed to deal exclusively with social science, nicely captures the three basic divisions of fact-finding that courts must process. Most importantly, their social framework category is a significant leap forward in clarifying the challenges associated with integrating empirical research into legal decision-making. Indeed, arguably the social authority (*i.e.*, legislative facts) and social facts (*i.e.*, adjudicative facts) are merely components of social frameworks, with the latter two being defined as a function of the legal use for evidence, not its scientific nature. In other words, all empirical research is conceivable in terms of frameworks, because it invariably has both a general component and a specific component. Whether the general component is legally relevant at all and, if so, what it is relevant to prove, dictates in the Monahan-Walker model whether it is a “social authority” or “social framework.”

For example, consider the empirical question of the developmental competence of 16- and 17-year-olds. In the context of capital punishment, this general fact was used in *Roper v. Simmons*²⁹ to support the conclusion that applying the death

20. I too have participated in this endeavor, though my efforts were restricted to constitutional cases. See DAVID L. FAIGMAN, CONSTITUTIONAL FICTIONS: A UNIFIED THEORY OF CONSTITUTIONAL FACTS 43–62 (2008).

21. Kenneth Culp Davis, *An Approach to Problems of Evidence in the Administrative Process*, 55 HARV. L. REV. 364, 402–03 (1942).

22. *Id.* at 402; see also FED. R. EVID. 201(a), Advisory Committee’s Note (“Legislative facts are those which have relevance to legal reasoning and the lawmaking process, whether in the formulation of a legal principle or ruling by a judge or court or in the enactment of a legislative body.”).

23. Davis, *supra* note 21, at 402.

24. John Monahan & Laurens Walker, *Social Authority: Obtaining, Evaluating and Establishing Social Science in Law*, 134 U. PA. L. REV. 477 (1986) [hereinafter Monahan & Walker (1986)]; Laurens Walker & John Monahan, *Social Facts: Scientific Methodology*

as Legal Precedent, 76 CAL. L. REV. 877 (1988) [hereinafter Walker & Monahan (1988)]; Laurens Walker & John Monahan, *Social Frameworks: A New Use of Social Science in Law*, 73 VA. L. REV. 559 (1987) [hereinafter Walker & Monahan (1987)].

25. Walker & Monahan (1987), *supra* note 24, at 562.

26. Monahan & Walker (1986), *supra* note 24, at 490–91.

27. Walker & Monahan (1988), *supra* note 24, at 887.

28. Walker & Monahan (1987), *supra* note 24, at 563–67. According to Monahan and Walker’s social-framework model, the judge would consider and instruct the jury on the accuracy of the general claim, but the jury would also hear expert testimony on how the research applies to the case before it. *Id.* at 592. In traditional practice, however, the jury is the fact-finder for both components of social-framework evidence. For present purposes, I need not choose which procedural approach is the better one.

29. 543 U.S. 551, 569 (2005).

penalty to those who killed before reaching the age of majority was unconstitutional. As such, this legislative fact was informed by “social authority.” On the other hand, if the question was whether a particular 16- or 17-year-old had competently waived his *Miranda* rights, the research used in *Roper* would be employed to inform a “social framework.”³⁰ In the case involving the waiving of *Miranda* rights, the court would have to apply the framework to the individual case, thus paradigmatically using both components of Monahan and Walker’s social-framework category.

EMPIRICAL FRAMEWORKS

For the purpose of examining evidentiary incommensurability between law and science, the Monahan and Walker concept of social frameworks is all that is specifically needed. It fully captures the juxtaposition of the inordinate empirical difficulties surrounding the use of group data to make individual decisions and the law’s frequent need to do just that. Since the phenomenon of interest extends well beyond social science, and includes all applied science with policy implications, the term “empirical framework” is more accurate and will be used here. The following sections, therefore, consider the legal demands on empirical research, from both the more conciliatory use of general research data to answer general legal propositions, to the more demanding use of general data to reach individualized judgments.

DEFINING THE “FRAME”

Because ordinary science operates at the general level of descriptive and inferential statistics, it can be readily employed to determine general propositions. Consider, for example, a hypothesis that has been the subject of several legal cases: violent video games cause minors who play them to be violent and asocial. This hypothesis has been studied in a multitude of ways, including observational case studies, correlational studies, laboratory experiments, brain imaging, and so forth.³¹ If these differing methods point in the same direction, then some general conclusions might be made regarding the relationship between violent video games and violence among children. If they point in different directions, of course, the task is complicated greatly, if not made impossible, until more research is done. But even when the body of research is robust, conclusions are likely to be tentative and, at best, described in probabilistic terms.

The legal relevance of the science, however uncertainly known, depends on the substantive law of the case. In regard to the violent video game example, then, this hypothesis might be relevant as a general proposition (e.g., do violent video games lead to increased violence among children?) or as that

research might apply in a particular case (e.g., was the minor defendant’s violent action attributable to having played violent video games?).

In the law, most litigation tends to involve the application of general principles to a specific case. Frequently, however, a general proposition of science is itself at issue. A good example of this, coming from the violence-in-media example, is the case *Entertainment Software Association v. Blagojevich*.³² In *Entertainment Software*, several video-game-industry trade associations sued the State to enjoin the enforcement of two statutes that regulated the content of violent and sexually explicit video games. The plaintiffs argued that the State’s laws violated the Free Speech Clause of the First Amendment. The district court agreed that the laws implicated First Amendment rights and held that the legislation could survive only if the State had a compelling interest that would be substantially achieved by the laws. The court found that “[t]he Illinois General Assembly’s main justifications were three legislative findings about the effect of playing video games on minors’ physiological and neurological development.”³³ According to the court, the legislature believed that playing violent video games makes children (1) “exhibit violent, asocial, or aggressive behavior”; (2) “[e]xperience feelings of aggression”; and (3) “[e]xperience a reduction of activity in the frontal lobes of the brain which is responsible for controlling behavior.”³⁴ In concluding that Illinois had not met its considerable burden, the court extensively reviewed psychological and neurological research that had been advanced by the State. The court explained that the State “failed to present substantial evidence showing that playing violent video games causes minors to have aggressive feelings or engage in aggressive behavior.”³⁵ Moreover, the court stated that “there is barely any evidence at all, let alone substantial evidence, showing that playing violent video games causes minors to ‘experience a reduction of activity in the frontal lobes of the brain which is responsible for controlling behavior.’”³⁶ The court permanently enjoined the Illinois law.

The second hypothesis, that a particular minor’s violent action is attributable to having played violent video games, is the more typical courtroom situation in regard to scientific evidence. In these cases, both the general hypothesis and the specific hypothesis are at issue. Although the defense is unusual, defendants have on occasion argued insanity on the basis of

“[There are] inordinate empirical difficulties surrounding the use of group data to make individual decisions.”

30. See, e.g., Thomas Grisso, *Juveniles’ Capacities to Waive Miranda Rights: An Empirical Analysis*, 68 CAL. L. REV. 1134 (1980).

31. See generally Craig A. Anderson, *An Update on the Effects of Playing Violent Video Games*, 27 J. ADOLESCENCE 113 (2004) (reviewing the literature).

32. 404 F. Supp. 2d 1051, 1059 (N.D. Ill. 2005).

33. *Id.* at 1073.

34. *Id.*

35. *Id.* at 1074 (The court added that, “[a]t most, researchers have been able to show a correlation between playing violent video games and a slightly increased level of aggressive thoughts and behavior.”).

36. *Id.*

“The principal tool used to move from general research findings to statements about individual cases is ‘differential etiology’”

video programming.³⁷ In *Zamora v. State*,³⁸ for example, “Zamora’s insanity defense was based upon ‘involuntary subliminal television intoxication.’” In particular, defense counsel argued that violent television had a noxious influence on sociopathic children and that Zamora had killed as a consequence of this effect.³⁹ To support this theory, the defense offered two experts. The first, a psychologist, offered to testify to the effect of television on adoles-

cents generally.⁴⁰ A second expert, a psychiatrist, testified that the defendant “did not know right from wrong” when he “fired the fatal shot,” thus applying the general theory of the case to the particular defendant. The court excluded the psychologist on the ground that she could not speak to Zamora’s individual case. The psychiatrist testified at trial, but apparently to little effect, since Zamora was convicted.

In the courtroom, research on general propositions, such as whether violent media causes an increase in violence among children, addresses a threshold question and one which scientists are trained to address. In an insanity defense to murder, however, the question is whether the particular person’s violence was caused by exposure to violent media. This issue of specific application poses a complex and difficult cognitive exercise. Moreover, it is an exercise that varies in different empirical contexts. It is also a subject that has been substantially ignored by scientists interested in the courtroom use of their data.

REASONING TO THE SPECIFIC

Although the challenge of reasoning from general research data to individual cases has been considered in a fairly cursory manner by courts and legal scholars, the basic challenges are fairly easily summarized. This is especially so in the conventional toxic-tort-litigation context, the area in which courts have most often considered it. In a nutshell, the first task is to demonstrate that the substance could have caused the ailment (*i.e.*, the validity of the general proposition); the second task is to show both that it probably did, and that other substances probably did not, cause the plaintiff’s condition.

The simplest case of this reasoning process might involve general research that indicates that some substance causes an ailment that is uniquely associated with that substance. For instance, as noted in Part I, asbestos has been shown to cause

mesothelioma, and it is the only substance known to cause it.⁴¹ Since mesothelioma is a “signature disease,” the only question concerns the circumstances of the individual’s exposure to asbestos (*i.e.*, was the defendant responsible?), not whether exposure caused the condition. The cause-and-effect path-specificity operates in this example to permit straightforward logical deductions from the general data to individual cases. This is rare in toxic tort litigation. For example, in contrast to asbestos, while second-hand smoke has been linked to lung cancer, many other substances are known to cause lung cancer. Hence, in regard to identifying the cause of a person’s lung cancer, an expert must not only rule in smoking as a possible cause but also rule out other possible causes.⁴²

The principal tool used to move from general research findings to statements about individual cases is “differential etiology,” sometimes misleadingly referred to as “differential diagnosis.” Properly understood, differential diagnosis refers to the identification of the illness or behavioral condition that a person is experiencing. Differential etiology refers to the cause or causes of that condition. Hence, the determination that a person suffers from “dissociative amnesia” and not “dissociative fugue” is a diagnostic issue.⁴³ The determination that a sexual assault at age ten caused the diagnosed dissociative amnesia, and that it did not result from a medical condition or physical trauma, is an etiological matter. Very different skill sets are usually involved in these two determinations. Indeed, the American Psychiatric Association’s Diagnostic and Statistical Manual of Mental Disorders (the DSM) explicitly eschews any claim of the etiological verity of its diagnostic categories.⁴⁴ It is worth emphasizing, as well, that the validity of the diagnosis of dissociative amnesia is a matter of general research. The entire process of differential diagnosis and differential etiology assumes that the designated category has adequate empirical support in the first place as a general proposition. Hence, although it is logically obvious, it should be stated plainly that an expert should never be permitted to testify about a specific application of a general proposition if research does not adequately support the general proposition.

In the professional practice of both clinical medicine and clinical psychology, the primary concern is diagnosis and not etiology. An oncologist might be curious about what caused his or her patient’s leukemia, but the doctor’s first task is to diagnose and treat the condition, not determine whether it was caused by trichloroethylene, benzene, electromagnetic fields, or something else. Similarly, a psychologist treating a person thought to suffer from either PTSD or adjustment disorder is primarily concerned with identifying and treating the condition, not determining the true causes of that condition. In the

37. See generally Jonathan Chananie, *Violent Videogames, Crime, and the Law: Looking for Proof of a Causal Connection*, 26 DEV. MENTAL HEALTH L. 27, 43 (2007) (listing cases); Patricia J. Falk, *Novel Theories of Criminal Defense Based Upon the Toxicity of the Social Environment: Urban Psychosis, Television Intoxication, and Black Rage*, 74 N.C. L. REV. 731 (1996) (same).

38. 361 So. 2d 776, 779 (Fla. Dist. Ct. App. 1978).

39. *Id.*

40. *Id.*

41. Victor Roggli, *Asbestos: Scientific Status*, in 3 MODERN SCIENTIFIC EVIDENCE: THE LAW AND SCIENCE OF EXPERT TESTIMONY, *supra* note 7, at § 26.

42. Faigman et al., *Tobacco: Legal Issues*, in 3 MODERN SCIENTIFIC EVIDENCE: THE LAW AND SCIENCE OF EXPERT TESTIMONY, *supra* note 7.

43. AM. PSYCHIATRIC ASS’N, DIAGNOSTIC AND STATISTICAL MANUAL OF MENTAL DISORDERS §§ 300.12–.13 (4th ed., text revision 2000).

44. *Id.* at xxxvii.

ordinary practice of clinical medicine and clinical psychology, treatment and therapy are the principal objectives, not assessing cause. A person presenting symptoms associated with PTSD, therefore, may claim that the traumatic event was a sexual assault committed by her uncle. From the therapeutic standpoint, at least at the start, the important factor is that there was a traumatic event. Whether the patient's uncle was the cause need not be specifically resolved for diagnostic purposes. In the law, of course, who caused the traumatic event is the crux of the matter. Hence, the core nature of much clinical practice is at right angles to the crux of most legal inquiries.

In the courtroom, differential etiology is the operative issue. Moreover, the same basic principle is implicated, whether the expert opinion comes from research-based science or clinical practice (*i.e.*, "experience"). Indeed, at least superficially, the former suffers a comparative disadvantage, since the research tradition does not ordinarily purport to offer conclusive statements about individual cases. Research, for example, might identify factors highly associated with false confessions, but these general propositions are some distance from what is needed to allow experts to opine regarding the truth or falsity of any particular confession. Clinicians at least have a history of applying general knowledge to individual cases, though, as noted, while this practice might be well accepted for therapeutic purposes, its validity for forensic ends is somewhat doubtful. Whether researchers or clinicians have the wherewithal to help triers of fact in applying general research propositions to specific cases is a threshold legal matter that should depend on the reliability and validity of the differential etiology done in the respective case. It may be, that is, that in vast areas of clinical practice there is no general research foundation in the first instance. And, as stated above, if research does not support a general proposition—say, the phenomenon of repressed memories—then clinical expert testimony that a particular person has repressed certain memories of early sexual abuse cannot be sustained.

DIFFERENTIAL ETIOLOGY

Differential etiology is a reasoning process that involves a multitude of factors, few of which are easily quantified. An expert offering an opinion regarding a specific case must first consider the strength of the evidence for the general proposition being applied in the case. If the claim is that substance X caused plaintiff's condition Y, the initial inquiry must concern the strength of the relationship between X and Y as a general proposition. For example, both second-hand smoke and first-hand smoke are associated with lung cancer, but the strength of the relationship generally is much stronger for the latter than it is for the former. The inquiry regarding strength of relationship will depend on many factors, including, among other things, the statistical strength of any claims and the quality of

the methods used in the research. Additionally, the general model must consider the strength of the evidence for alternative possible causes of Y and the strength of their respective relationships (and possibly interactions with other factors). Again, the quality of the research and the different methodologies employed will make comparisons difficult. Complicating matters further regarding identification of potential causes of condition Y are the myriad of possible causes that have not been studied, or have been studied inadequately.⁴⁵ Hence, determining the contours of the general model is a dicey affair in itself, since it requires combining disparate research results and discounting those results by an unknown factor associated with additional variables not yet studied. And this is just the first part of the necessary analysis if the expert wants to give an opinion about an individual case.

The second part of the analysis—specific application of general propositions that are themselves supported by adequate research—requires two abilities, neither of which are clearly within most scientists' skill sets. The first, and perhaps less problematic, is that of forensic investigator. Almost no matter what the empirical relationship, whether medical or psychological, exposure or dosage levels will be relevant to the diagnosis. The first principle of toxicology is that "the dose makes the poison," since any substance in sufficient quantities could injure or kill someone.⁴⁶ Similarly, in a wide variety of psychological contexts, the exposure or dose will be the poison. For instance, degree of trauma affects diagnostic categorization between PTSD and adjustment disorder, level of anxiety affects eyewitness identifications, amount of lack of sleep affects false confession rates, and so on. The expert testifying to specific causation must determine exposure and dosage levels for the suspected cause (*i.e.*, the source suspected by the client) as well as for all other known or possible causes. This task is difficult enough alone but is enormously complicated by the significant potential for recall bias, given that the litigation will be profoundly affected by what is recalled.

The second skill set that is needed has not yet been invented or even described with precision. Somehow, the diagnostician must combine the surfeit of information concerning the multitude of factors that make up the general model, with the case history information known or suspected about the individual, and offer an opinion with some level of confidence that substance or experience X was the likely cause of condition Y. In practice, this opinion is usually stated as follows: "Within a reasonable degree of medical/psychological certainty, it is my opinion that X caused [a particular case of] Y." This expression

"Differential etiology is a reasoning process that involves a multitude of factors. . . ."

45. In *Henricksen v. Conocophillips Co.*, 605 F. Supp. 2d 1142 (E.D. Wash. 2009), the court observed that 80 to 90% of the causes of acute myelogenous leukemia (AML) were unknown ("idiopathic"). *Id.* at 1149. The court stated that "[i]f 90 percent of the causes of a disease are unknown, it is impossible to eliminate an unknown disease as the efficient cause of a patient's illness." *Id.* at

1162 (quoting *Whiting v. Boston Edison Co.*, 891 F. Supp. 12, 21 n.41 (D. Mass. 1995)).

46. Bernard D. Goldstein & Russellyn Carruth, *Toxicology: Scientific Status*, in 3 MODERN SCIENTIFIC EVIDENCE: THE LAW AND SCIENCE OF EXPERT TESTIMONY, *supra* note 7, at § 22.

has no empirical meaning and is simply a mantra repeated by experts for purposes of legal decision makers who similarly have no idea what it means. But even less extreme versions of this statement—such as, “It is more likely than not true that this case is an instance of some general phenomenon”—are objectionable. Just how, for instance, would an eyewitness researcher determine that a witness was more likely than not inaccurate when the witness made a cross-racial identification of the defendant after seeing the unarmed perpetrator for five minutes under a streetlight from an unobstructed view 20 feet away from the crime? There is no data that would support psychologists’ ability to make such statements, however modest or innocuous such statements may appear. Experts’ case-specific conclusions appear to be based largely on an admixture of an unknown combination of knowledge of the subject, experience over the years, commitment to the client or cause, intuition, and blind faith. Science it is not.

Whether, and in what way, particular scientific findings are relevant to legal decision-making depends on the substantive law of the case. Frequently, the relevant factual issue under applicable law involves general propositions, ones that population-based research corresponds to directly. Much more often, however, the empirical focus of the ultimate legal issue is on the particular case. But conventional scientific methods do not share this focus. Although research data might demonstrate with high confidence that a particular variable has an effect of interest, it typically cannot demonstrate with the same confidence that the particular variable had the effect of interest in a particular case. Reconciling this evidentiary incommensurability between what science ordinarily does and what the law ordinarily needs is, as yet, one of the great unmet challenges at the intersection of science and the law.

CONCLUSION

Most evidentiary codes require that expert testimony “assist the trier of fact” in order for it to be admissible.⁴⁷ Scientific expert testimony, however, must be legally relevant and have evidentiary reliability (i.e., scientific validity).⁴⁸ Moreover, expert opinion must offer insights beyond what triers of fact could do on their own. Put another way, scientist-experts are limited to testifying about what their respective field’s research

can validly add to fact-finders’ deliberations—and nothing more. This injunction, however, is not always followed. In particular, experts frequently seek to comment not simply on the import of general research findings, but on whether a particular case fits those findings. Scientific research that permits a valid description of a general phenomenon, however, does not invariably give experts the capacity to validly determine whether an individual case is an instance of that general phenomenon.

A basic difference in perspective between science and the law is that science studies individuals in order to make statements about populations, while the law studies populations in order to make statements about individuals. It does not necessarily follow that a scientist who can validly describe a general phenomenon also has the wherewithal to say whether an individual case is an instance of that general phenomenon. In many respects, the matter of translating scientific research findings into helpful information for fact-finders in court should be a subject of first concern for applied science. Yet this issue has been largely ignored by scientists. This essay calls for a broadly conceived collaborative effort to consider this basic issue, one that is endemic to the intersection of law and science.



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47. FED. R. EVID. 702.

48. *Daubert v. Merrell Dow Pharms., Inc.*, 509 U.S. 579, 591 (1993).

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The Admissibility of Brain Scans in Criminal Trials:

The Case of Positron Emission Tomography

Susan E. Rushing

The *People of the State of New York v. Herbert Weinstein* (1992)¹ is one of the earliest and most prominent examples of an attorney offering a Positron Emission Tomography (PET) scan as evidence in a criminal trial. Mr. Weinstein, a 68-year-old, married, Caucasian male worked in advertising. Mr. Weinstein had no past criminal history and no history of violence, but he was accused of strangling his wife and throwing her body from their 12th-story Manhattan apartment to make her death appear to be a suicide. When confronted, Mr. Weinstein admitted his guilt and even readily admitted his attempts to cover up his crime.² Mr. Weinstein's lack of emotion when discussing the crime and apparent lack of remorse for his action caused his legal team to question whether the older gentleman could be suffering from a neurological impairment that caused an uncharacteristic act of aggression.³

Acts of aggression have been hypothesized to arise from dysfunction within the prefrontal cortex and impaired connections between the frontal lobe and associated limbic brain regions. Physicians consulting with Mr. Weinstein's defense attorneys suggested Mr. Weinstein undergo neuropsychological testing and brain scanning that could demonstrate potential structural and/or functional deficits in his brain.⁴

An MRI of Mr. Weinstein's brain revealed a large cyst in the arachnoid mater, a protective lining that covers the brain tissue. The arachnoid cyst was situated within the left sylvian fissure and compressed the left frontal, temporal, and insular regions of Weinstein's brain. A functional scan of Mr. Weinstein's brain demonstrated that the areas of brain tissue that were compressed by the cyst were not metabolizing glucose at the expected rate. Mr. Weinstein's attorneys offered the PET scan in support of a claim of not guilty by reason of insanity (NGRI). Prosecutor Zachery Weiss moved for an order to preclude Weinstein from offering any testimony or other evidence concerning his PET scan. The prosecution argued that PET scans were not accurate or reliable depictions of cerebral

metabolism.⁵ The prosecutor further argued that the idea that hypometabolism in the frontal lobes causes frontal lobe dysfunction was not generally accepted in the psychiatric and neurological community.⁶ Likewise, Weiss argued that it was debatable whether a causal link could be established between the presence of a congenital cyst and a single violent act. A *Frye* hearing followed, and Judge Richard Carruthers considered whether the PET scan was generally accepted as a diagnostic instrument within the psychiatric and neurological community.⁷

A PET scan measures brain function by determining the brain's use of glucose—the main energy source for the brain. Brain cells, called neurons, need glucose to survive and to function properly. In order to assess glucose metabolism, glucose is radioactively labeled with a tracer. The most common radiotracer in use today in PET scanning is ¹⁸F-fluorodeoxyglucose (¹⁸F-FDG).⁸ FDG-PET is the only established technique that allows analysis of brain glucose metabolism in a live person. Before the PET scan, ¹⁸F-FDG is injected into the vein of a patient who has previously been fasting. As the radioactive glucose is metabolized by the brain, a pair of photons is emitted and captured by detectors within the PET scanner through a process called co-incidental detection.⁹ The scanner records the number of times that photons are captured. The resulting counts are used to calculate a metabolic rate. The metabolic rates are displayed in color-coded fashion in which metabolic increases are typically shown in shades from yellow to red and metabolic decreases are shaded from blue to purple. The ¹⁸F-FDG PET (FDG-PET) images are used to determine sites of abnormal glucose metabolism and can be used to characterize and localize brain abnormalities.

Edward Hoffman and Michael Phelps developed the PET scanner in 1973, and techniques for diagnosing diseases in humans soon followed. FDG-PET is an accepted clinical test

Footnotes

1. *People v. Weinstein*, 591 N.Y.S.2d 715 (N.Y. Sup. Ct. 1992). For an excellent discussion of the *Weinstein* case including commentary from attorneys and expert witnesses, see Owen D. Jones, Jeffrey D. Schall & Francis X. Shen, *The Case of the Murdering Brain*, in *LAW AND NEUROSCIENCE* 41–67 (2014).
2. Daniel A. Martell, *Causal Relation Between Brain Damage and Homicide: The Prosecution*, 1 *SEMINARS IN CLINICAL NEUROPSYCHIATRY* 184 (1996).
3. Norman Relkin et al., *Impulsive Homicide Associated with an Arachnoid Cyst and Unilateral Frontotemporal Cerebral Dysfunction*, 1 *SEMINARS IN CLINICAL NEUROPSYCHIATRY* 172 (1996).
4. *Id.*

5. Zachary Weiss, *The Legal Admissibility of Positron Emission Tomography Scans in Criminal Cases: People v. Spyder Cystkopf*, 1 *SEMINARS IN CLINICAL NEUROPSYCHIATRY* 202 (1996).
6. *Id.*
7. *Weinstein*, 591 N.Y.S.2d 715.
8. In this paper, the radiotracer used in PET scanning is ¹⁸F-FDG. The term PET will signify ¹⁸F-FDG PET.
9. For a detailed explanation of how a PET scanner measures glucose metabolism, see Susan E. Rushing & Daniel D. Langleben, *Nuclear Neuro-imaging, PET and SPECT*, in 1 *NEUROIMAGING IN FORENSIC PSYCHIATRY: FROM THE CLINIC TO THE COURTROOM* 3 (J. Simpson ed., 2012).

used to diagnose and monitor cancer,¹⁰ epilepsy,¹¹ and degenerative brain disease.¹² FDG-PET is also used for pre-surgical planning, in post-stroke evaluation,¹³ and for evaluation of moderate to severe traumatic brain injury.¹⁴ PET is used by forensic medicine practitioners to demonstrate diffuse axonal injury, which is characteristic of mild traumatic brain injury.¹⁵

The similar single-photon emission computed tomography (SPECT) is used to characterize neurodegenerative disorders such as dementia, stroke, seizures, inflammation, and trauma.¹⁶ SPECT uses the radioisotope technetium-99m (99mTc), a compound with a much longer half-life than ¹⁸F-FDG. The breakdown of 99mTc results in the emission of a single photon. The imaging data is captured by a gamma camera, which is rotated around the patient. The SPECT radioisotopes are more accessible and less expensive than the PET radioisotopes, which must be produced in a specialized cyclotron and used within hours of its production.

Only since the early 1990s have courts been confronted with admissibility questions regarding the use of nuclear medicine studies, including PET and SPECT technologies, in criminal trials. The primary issue that judges consider is whether the information provided by the scan will assist the jury in determining an issue regarding the cognitive capacity of the criminal defendant. This information is not given the same level of relevance in every court phase. At sentencing in all death-penalty cases, the jury must consider the defendant's cognitive and neuropsychological limitations. But during the guilt phase of a criminal trial, brain imaging studies are generally offered to substantiate a diagnosis or to offer a causal link between a brain-based abnormality and violent behavior. At no point in a criminal trial can nuclear studies be used to determine whether the defendant committed the act in question. And brain images cannot assist the jury in understanding the emotional mindset of the defendant at the time of the crime. However, nuclear medicine studies can demonstrate brain-based abnormalities, which may suggest that a defendant had a limited capacity for self-control.

In *Weinstein*, the defendant underwent a resting-state PET protocol, and his brain's metabolic rate was compared to a group of controls. The PET scan demonstrated that Mr. Weinstein had abnormally low levels of glucose metabolism in the areas of his brain that were compressed by the cyst and in the brain regions opposite to the cyst. There was no doubt that the presence of the cyst altered Mr. Weinstein's brain structure and function. However, the question before the court was one of causation. Was there sufficient evidence to allow psychiatric and neurological experts to testify that Mr. Weinstein's brain abnormality was related to his violent criminal behavior? Further, could a psychiatrist reasonably opine that Mr. Weinstein's abnormal brain function made him unable to appreciate the wrongfulness of his action and therefore rendered him insane as defined by the State of New York?

Judge Carruthers found that the scientific community generally accepted that PET scans provide a reliable measure of brain glucose metabolism. Judge Carruthers also noted that it is generally accepted in the fields of psychiatry, psychology, and neurology that the frontal lobes of the human brain control executive functions, including the abilities to reason and to plan.¹⁷ The court accepted that damage to the frontal lobes could cause cognitive impairment and that the impairment could specifically be in the areas of judgment, insight, and foresight. The defense planned to call a psychiatrist to testify that, at the moment Weinstein allegedly killed his wife, his cognitive impairment prevented him from understanding that his conduct was wrong and that his impairment was in part due to organic brain damage from the cyst. Judge Carruthers

"[N]uclear medicine studies can demonstrate brain-based abnormalities, which may suggest that a defendant had a limited capacity for self-control."

10. Jamshed B. Bomanji, Durval C. Costa & Peter J. Ell, *Clinical Role of Positron Emission Tomography in Oncology*, 2(3) LANCET ONCOLOGY 157 (2001); Hatem Necib et al., *Detection and Characterization of Tumor Changes in ¹⁸F-FDG PET Patient Monitoring Using Parametric Imaging*, 52 J. NUCLEAR MED. 354 (2011).
11. Yu K. Kim et al., *¹⁸F-FDG PET in Localization of Frontal Lobe Epilepsy: Comparison of Visual and SPM Analysis*, 43 J. NUCLEAR MED. 1167 (2002); Yu K. Kim et al., *Differential Features of Metabolic Abnormalities Between Medial and Lateral Temporal Lobe Epilepsy: Quantitative Analysis of ¹⁸F-FDG PET Using SPM*, 44 J. NUCLEAR MED. 1006 (2003).
12. Béatrice Desgranges et al., *The Neural Substrates of Episodic Memory Impairment in Alzheimer's Disease as Revealed by FDG-PET: Relationship to Degree of Deterioration*, 125 BRAIN 1116 (2002); Kazunari Ishii et al., *Statistical Brain Mapping of ¹⁸F-FDG PET in Alzheimer's Disease: Validation of Anatomic Standardization for Atrophied Brains*, 42 J. NUCLEAR MED. 548 (2001); Yong Jeong et al., *¹⁸F-FDG PET Findings in Frontotemporal Dementia: An SPM Analysis of 29 Patients*, 46 J. NUCLEAR MED. 233 (2005); Raheong Juh et al., *Different Metabolic Patterns Analysis of Parkinsonism on the ¹⁸F-FDG PET*, 51 EUROPEAN J. RADIOLOGY 223 (2004); Andrew

- B. Newberg & Abass Alavi, *The Role of PET Imaging in the Management of Patients with Central Nervous System Disorders*, 43 RADIOLOGY CLINICS N. AM. 49 (2005).
13. Beau M. Ances et al., *Early Uncoupling of Cerebral Blood Flow and Metabolism After Bilateral Thalamic Infarction*, 25 AM. J. NEURORADIOLOGY 1685 (2004).
14. Marvin Bergsneider et al., *Dissociation of Cerebral Glucose Metabolism and Level of Consciousness During the Period of Metabolic Depression Following Human Traumatic Brain Injury*, 17 J. NEUROTRAUMA 389 (2000); Ronald M. Ruff et al., *Selected Cases of Poor Outcome Following Minor Brain Trauma: Comparing Neuropsychological and Positron Emission Tomography Assessment*, 8 BRAIN INJURY 297 (1994).
15. Samuel H. Mehr & Stephen L. Gerdes, *Medicolegal Applications of PET Scans*, 16 NEUROREHABILITATION 87 (2001); Noel Rao et al., *¹⁸F Positron Emission Tomography in Closed Head Injury*, 65 ARCHIVES PHYSICAL MED. REHABILITATION 780 (1984).
16. Nadine J. Dougall, Sjoerd Bruggink & Klaus P. Ebmeier, *Systematic Review of the Diagnostic Accuracy of 99mTc-HMPAO-SPECT in Dementia*, 12 AM. J. GERIATRIC PSYCHIATRY 554 (2004).
17. Weinstein, 591 N.Y.S.2d at 724.

“[T]here continues to be debate concerning the admissibility of FDG-PET and the appropriateness of expert witness testimony discussing brain scans in the courtroom.”

placed a limitation on the defense witnesses’ testimony and would not permit them to opine either that the cyst or reduced levels of glucose metabolism in the frontal lobes of the brain directly caused Weinstein’s violence.

Nevertheless, Judge Caruthers noted that such assertions would not be generally accepted as valid in the fields of psychiatry, psychology, and neurology. He specifically noted that the sensitivity and specificity of frontotemporal hypometabolism

for impulsivity and violence is unknown. He noted that there were no published controlled PET studies of either episodic violence or subarachnoid cysts, nor were there imaging studies of cyst patients with and without incidents of violence.

There is no legal record of how Weinstein’s insanity claim fared before a jury because on the eve of trial he agreed to plead guilty to manslaughter. Weinstein was sentenced to 7 to 21 years in prison. A surgeon can drain an arachnoid cyst; however, there is a risk of reaccumulation of the cyst. Mr. Weinstein did not undergo cyst drainage. He was incarcerated for more than 12 years and did not engage in any violent acts while in prison.¹⁸ He was granted a conditional release at age 79 and died 2 years after his release. More than 20 years later, arachnoid cysts remain a common incidental finding in neuro-radiologic studies. Arachnoid cysts can lead to epilepsy, headache, and other neuropsychiatric impairment, but no studies directly link this brain abnormality with violence.

PET IN CRIMINAL TRIALS: CURRENT TRENDS IN ADMISSIBILITY

Despite the acceptance of PET in the *Weinstein* case in 1992, today there continues to be debate concerning the admissibility of FDG-PET and the appropriateness of expert witness testimony discussing brain scans in the courtroom.¹⁹ This section reviews the most prominent concerns about the introduction of these brain scans into evidence and explains how the admissibility calculus differs depending on the phase of the legal proceeding. It will review the introduction of scans at pretrial competency hearings and the guilt and sentencing phases of criminal trials and conclude that courts are most willing to admit brain-scan evidence at the sentencing phase.

Admission of PET at Pretrial Competency Hearings

The standard for assessing competency to stand trial was set out in *Dusky v. United States*²⁰ and has since been adopted by

many state jurisdictions. *Dusky* requires that a defendant possess a reasonable capacity to understand the criminal process and be able to function in that process. Mental illness, brain injury, dementia, and mental retardation can significantly affect these abilities. If a defendant is found incompetent to stand trial, the trial is delayed until the defendant becomes competent to respond to the charge. However, there are some conditions that cannot be remedied, and therefore, neither the passage of time nor treatment is likely to restore competence. In these cases, the prosecutor may choose not to pursue certain charges or may request that a defendant be committed to a mental facility to attempt to restore the defendant’s competence.

The ultimate fate of incompetent defendants was addressed in *Jackson v. Indiana* (1972).²¹ Jackson was a 27-year-old man who suffered from an intellectual disability, deafness, and muteness. He was unable to read, write, or otherwise communicate except through limited sign language. Jackson was charged with theft of five dollars and a purse and its contents, estimated to be worth four dollars. Mr. Jackson was not able to communicate with his attorney, so his legal team sought assistance from a teacher at the school for the deaf. The teacher stated that Jackson did not possess adequate sign-language skills for communication and that he would be unable to comprehend the proceedings or aid counsel due to his intellectual disability. The State of Indiana had no facilities that could provide Jackson with rehabilitation for this form of incompetency, and the Supreme Court found that indefinite commitment would violate the defendant’s right to due process.²² The Supreme Court stated that a defendant committed to a mental facility solely on the basis of incompetency “cannot be held more than the reasonable period of time necessary to determine whether there is a substantial probability that he will attain that capacity in the foreseeable future.”²³

Today forensic psychiatrists are routinely asked to evaluate defendants’ competence to stand trial. If the physician deems a defendant incompetent, the physician will be asked to predict whether the defendant’s competence can be restored and what sort of treatment may be necessary to accomplish restoration. There will be cases in which it will be clear to a reasonable degree of medical certainty that competence to stand trial cannot be restored. In some cases, functional imaging may be part of the medical workup to determine the severity of a brain-based cause for incompetency.

Competency is likely to be a growing concern as the population ages. More than 3 million people living in the United States suffer from dementia, a degenerative brain condition.²⁴ As the population of Americans over age 65 is predicted to double by 2030, the number of people with dementia—a risk factor for violence—is also likely to dramatically increase.²⁵

Dementia, including Alzheimer’s-type dementia, frontotemporal dementia (Pick’s Disease), and Parkinson’s disease, are

18. *Weinstein v. Dennison*, 801 N.Y.S.2d 244 (N.Y. Sup. Ct. 2005).

19. Paul S. Appelbaum, *Through a Glass Darkly*, 60 PSYCHIATRIC SERVICES 21 (2009).

20. *Dusky v. United States*, 362 U.S. 402 (1960).

21. *Jackson v. Indiana*, 406 U.S. 715 (1972).

22. *Id.* at 725.

23. *Id.* at 738.

24. Brenda L. Plassman et al., *Prevalence of Dementia in the United States: The Aging, Demographics, and Memory Study*, 29 NEUROEPIDEMIOLOGY 125 (2007).

25. Gregory J. Paveza et al., *Severe Family Violence and Alzheimer’s Disease: Prevalence and Risk Factors*, 32(4) GERONTOLOGIST 493 (1992).

currently irreversible and incurable. While medications may slow the progression of these diseases, people with cognitive deficits caused by these illnesses are not expected to regain lost cognition. In cases of severe cognitive impairment that prevents defendants from working with their defense attorneys, findings of incompetence to stand trial are possible. FDG-PET can be used to diagnose dementia.²⁶ And depending on the severity of the crimes, the prosecuting attorneys may require more evidence to support the alleged irreversible diagnoses.

The following case provides an example of a PET scan that showed organic brain dysfunction but failed to persuade a court that a defendant was not competent to stand trial.

In *United States v. Vincent Gigante*, the mafia boss known as “the Chin” claimed he was incompetent to stand trial for conspiracy and racketeering.²⁷ Mr. Gigante was court ordered to undergo a competence examination after his legal team claimed he suffered from Alzheimer’s-type dementia. A PET study was offered in support of this finding. The court admitted the PET evidence but declined to rely upon it. The court noted that the scan was of “excellent technical quality but [offered] a number of difficulties in interpretation.” Specifically the court was concerned that the controls in the study were not treated with the same psychotropic drugs as Mr. Gigante.

Defense witness Dr. Monte Buchsbaum of Mount Sinai School of Medicine interpreted the PET scans and concluded that Mr. Gigante was suffering from organic brain dysfunction, possibly due to Alzheimer’s disease or multi-infarct dementia. He believed Mr. Gigante was incapable of being tried. Neuropsychological testing by Dr. Wilfred Van Gorp of New York Hospital’s Cornell Medical Center also supported a diagnosis of severe cognitive impairment. However, the prosecution’s expert, Dr. Jonathan Brodie, a psychiatrist at New York University Medical School, testified that the results of both the neuropsychological tests and the PET scan could have been corrupted by medications that Mr. Gigante was taking.

Dr. Brodie criticized defense experts for not analyzing the defendant’s blood to determine the amount of medication in his system at the time the tests were administered. Mr. Gigante had been taking potent psychotropic medications for a long period prior to the PET scan and did not stop these medications prior to the scan. The medications could have altered blood flow to the brain or crossed the blood-brain barrier and potentially altered metabolism.²⁸ The members of the control group were not medicated at the time of their scans and were not close in age to Mr. Gigante. As a result, the court did not find the results of the PET persuasive. Ultimately, Mr. Gigante was found competent for sentencing and was sentenced to 12 years in federal prison in 1997.

But PET scans have been admitted to support a pretrial

motion of incompetence to stand trial. For example, Miguel Carrizalez was charged with two counts of murder, six counts of attempted murder, and gang-related charges in California.²⁹ Mr. Carrizalez had sustained a gunshot wound to the head and had a bullet lodged in his brain. He claimed incompetence to stand trial due to this severe traumatic brain injury and offered a PET scan in support. The prosecution

objected to the admission of the PET scan, and the court held a *Kelly-Frye* hearing.³⁰ During the competence hearing, the judge stated that PET studies are “generally accepted in the scientific community and . . . are certainly accepted as tools used in clinical settings. And in forensic settings it seems . . . there could be testimony as to the areas of the brain that are relevant to the issue of [trial competency].”³¹ The court admitted the PET study into evidence. Despite evidence of severe traumatic brain injury, Mr. Carrizalez was found competent to stand trial, and the PET scan was presented again during the sentencing phase of the trial. The jury convicted Mr. Carrizalez of all charges but did not return a unanimous vote in favor of the death penalty, a requirement to impose a death sentence in California. The district attorney did not retry the penalty phase, and Mr. Carrizalez was sentenced to life without the possibility of parole. The defense teams’ multiple reminders to the jury of the severity of Mr. Carrizalez’s brain injury both in the form of expert testimony and by pictorial demonstration may have led at least one juror to vote for life in prison rather than death in this double-homicide trial.

“In a capital case, neuroimaging can be used in two ways: first, during the guilt-or-innocence phase. . . , and second, in the penalty phase. . . .”

Admission of PET During the Guilt Phase of Criminal Trials

In a capital case, neuroimaging can be used in two ways: first, during the guilt-or-innocence phase in which the State must prove a defendant committed an alleged crime beyond a reasonable doubt, and second, in the penalty phase, where the jury decides whether a guilty defendant will receive a capital sentence. Admissibility challenges are far more likely to arise when PET images are submitted for consideration in the guilt phase of a criminal trial. During the guilt phase, PET may be introduced to support a defendant’s claim that he has a brain-based abnormality that affects his or her ability to form the requisite *mens rea* for the charged crime. When a defense attorney chooses to display a brain image in the guilt phase of a criminal trial, the image will almost certainly be presented by an

26. See Ishii et al., *supra* note 12; Jeong et al., *supra* note 12; Juh et al., *supra* note 12.

27. *United States v. Gigante*, 982 F. Supp. 140 (E.D.N.Y. 1997).

28. Mr. Gigante was reportedly taking Thorazine (chlorpromazine), Restoril (temazepam), Lanoxin (digoxin), Tenormin (atenolol), Pamelor (nortriptyline), and Dalmane (flurazepam) at the time of his scan.

29. Transcript of *Kelly-Frye* Hearing at 1-267, California vs. Miguel Carrizalez, (2011) (No. VCF 169926C).

30. A *Kelly-Frye* hearing is California’s evidentiary hearing for scientific evidence as detailed in *People v. Kelly*, 549 P.2d 1240 (Cal. 1976).

31. *Id.* at 261–62.

“Legal and medical scholars alike have feared the effect that [neuro] images could have on a jury determining a defendant’s guilt.”

expert, who will testify as to whether the defendant was capable of forming the *mens rea* needed to accomplish the crime. To negate *mens rea*, the expert must believe that a neurological defect caused the defendant to be unable to form the intent required to constitute a crime. In cases in which the expert plans to testify that a neurological deficit precludes *mens rea*, an evidentiary challenge is likely. But when the claim is diminished capacity due to a neurological deficit, an

evidentiary challenge is less likely to arise. Evidentiary challenges are rarely raised when neuroimaging is presented in the sentencing phase of trial.

Legal and medical scholars alike have feared the effect that images could have on a jury determining a defendant’s guilt.³² Critics fear a “Christmas tree effect,” whereby jurors may be unduly influenced by the visual display of a colorful brain scan and accept the scan as authoritative evidence without considering the merits of the expert’s accompanying testimony.³³ Critics have also feared that the expert testimony interpreting scans will prejudice or mislead the jury. Further, there is concern that a jury will find a misshapen or malfunctioning brain more persuasive than traditional forms of lay or expert testimony.³⁴ A study by Gurley and Marcus (2008) weighed the effects of structural neuroimaging with MRI used in support of an insanity defense in a simulated murder trial.³⁵ In this study, involving a sample of 400 mock jurors, jurors were more likely to find a defendant not guilty by reason of insanity (NGRI) if an MRI showing a brain lesion was presented than if no image was presented. Mock jurors were even more likely to choose NGRI when both expert testimony and neuroimaging was presented than when either type of evidence alone was presented. This study suggested that the combination of expert testimony and imaging can lead jurors to find that a defendant lacked the *mens rea* needed to commit murder.

However, in a mock study by Schweitzer, there were no increases in successful *mens-rea*-specific defenses when brain images were presented to the “jury.”³⁶ In the research study, brain images had no consistent impact on the verdicts or sentences rendered by the mock jurors.³⁷ Further, showing the mock jurors neuroimages also had no impact on jurors’ perceptions of the defendant’s criminal responsibility.³⁸

Admissibility challenges are less likely to prevail if the

defense offers the incomplete defense of diminished capacity or a variant thereof. When a defendant raises a diminished-capacity defense, the defendant suggests that he or she was deprived of a normal level of mental wherewithal at the time of the crime. Not every state employs this partial defense. In states that do, a successful plea of diminished capacity in a murder trial would likely result in a charge of first- or second-degree murder being reduced to manslaughter.

When introduced in the guilt phase of the trial, PET should aid the physician in making a diagnosis. In some cases, the court has required that PET demonstrate information that is not otherwise available to the clinician. In *People v. Goldstein*, the defendant, Andrew Goldstein, pushed Kendra Webdale in front of an oncoming subway train, killing her.³⁹ Both prosecution and defense experts agreed that defendant Goldstein had schizophrenia. At issue in the trial was whether he was insane at the time he pushed Kendra in front of the oncoming train. PET was offered by a defense expert witness to show that Goldstein’s brain imaging was consistent with schizophrenia. Specifically, the defense witness planned to testify that Mr. Goldstein had a massive reduction in metabolism in the frontal lobe and the basal ganglia.⁴⁰ A special master appointed by the court stated that PET cannot conclusively prove schizophrenia. He continued that regardless of any brain abnormality that PET could show, PET would not be probative of the key issue of the insanity defense, namely, whether Mr. Goldstein comprehended either the nature and consequences of his actions or that his actions were wrong. As PET was not offered to further probe into the impact of schizophrenia on the defendant’s cognition and behavior, it was excluded from evidence.⁴¹

In addition, an expert’s attempt to introduce PET to demonstrate that a particular process or substance altered brain metabolism can be risky if PET is not routinely used for such a diagnosis. Michael Jackson (not the pop star), a man with a history of phencyclidine (PCP) dependence, shot and killed West Covina Police Officer Kenneth Wrede in 1983 when Jackson was intoxicated on PCP.⁴² Mr. Jackson admitted to shooting Officer Wrede but maintained that he had no recollection of the encounter whatsoever. Defense put forth a defense of actual innocence under the theory that Mr. Jackson could not form the requisite *mens rea* required to commit the crime of first-degree murder. The defense expert offered a PET scan to demonstrate brain damage secondary to chronic PCP abuse. The prosecution expert testified that the use of PET scans to diagnose chronic PCP abuse is not generally accepted by the scientific community, and the defense expert did not dispute this fact. No evidence was introduced to suggest that a PET scan could prove that Jackson was unable to premeditate or

32. Teneille Brown & Emily Murphy, *Through a Scanner Darkly: Functional Neuroimaging as Evidence of a Criminal Defendant’s Past Mental States*, 62 STAN. L. REV. 1119 (2010).

33. *Id.* at 1190–91.

34. Deena S. Weisberg et al., *The Seductive Allure of Neuroscience Explanations*, 20 J. COGNITIVE NEUROSCIENCE 470 (2008).

35. Jessica R. Gurley & David K. Marcus, *The Effects of Neuroimaging and Brain Injury on Insanity Defenses*, 26 BEHAV. SCI. & L. 85 (2008).

36. Nicholas J. Schweitzer et al., *Neuroimages as Evidence in a Mens*

Rea Defense: No Impact, 17 PSYCHOL., PUB. POL’Y & L. 357 (2011).

37. *Id.*

38. For a summary of the above-mentioned study, see also Adina L. Roskies et al., *Neuroimages in Court: Less Biasing Than Feared*, 17 TRENDS COGNITIVE SCI. 99 (2013).

39. *People v. Goldstein*, 843 N.E.2d 727 (N.Y. App. Div. 2005).

40. *People v. Goldstein*, 786 N.Y.S.2d 428, 432 (N.Y. Sup. Ct. 2004).

41. *Goldstein*, 843 N.E.2d 727.

42. *Jackson v. Calderon*, 211 F.3d 1148 (9th Cir. 2000).

form specific intent to kill at the time of the shooting. The PET scan could not explain what effect PCP-induced brain damage would have on Jackson's capacity for higher thought. The appeals court found that the trial court did not err in excluding the PET scan and found that Jackson failed to make the required showing of probable innocence.⁴³

PET was also excluded from evidence in the case of *U.S. v. Montgomery*.⁴⁴ Lisa Montgomery had an online friendship with her pregnant victim Bobbie Jo Stinnett. The two had engaged in email exchanges about their respective "pregnancies." Montgomery arranged to meet Stinnett and buy a puppy from her. Montgomery strangled the expectant mother, performed a cesarean section, and kidnapped Stinnett's premature baby. Stinnett died, but her premature daughter survived. Montgomery crossed state lines with the baby, making her crime a federal offense. A PET scan was offered to support Montgomery's defense of pseudocyesis, or false pregnancy, a mental disorder that could have led to a diminished-capacity finding. The court found that a PET scan was not ever used as a diagnostic aid for pseudocyesis. Further, the abnormalities revealed on PET did not predict behavior, nor did the abnormality cause Montgomery to commit the crime. Accordingly, PET was excluded from evidence in the guilt phase of the trial. In this case PET was also excluded from evidence during the sentencing phase, but such exclusion at sentencing is exceedingly rare in death-penalty cases.

PET scans are also only admissible if unlikely to mislead the jury. In *United States v. Mezvinsky*,⁴⁵ Edward Mezvinsky, a former congressman, was charged with 69 violations of federal law arising from fraudulent schemes and related financial crimes. The crimes occurred over a 12-year period. In his defense, Mr. Mezvinsky offered a PET scan to demonstrate that he was incapable of deception, an element necessary to prove fraud. Dr. Ruben Gur, the Government's witness, and Dr. Jonathan Brodie, Mr. Mezvinsky's witness, agreed that no study exists that links the diminished capacities in various parts of Mezvinsky's brain to any specific disorder. Both agreed that a PET scan is only a snapshot of a patient's brain at one particular time and that one cannot make retrospective appraisals of that brain from such snapshots. Thus, neither expert could make any inference about the state of Mezvinsky's brain at any point during the 12 years in question. Neither expert could identify anything in the scan that would elucidate Mezvinsky's capacity to deceive.⁴⁶ Accordingly, the court found that the relevance of the evidence was outweighed by its capacity to mislead the jury, and PET was excluded from evidence in Mezvinsky's trial. Such a result is unlikely in the sentencing phase, however.

PET Admissions Rarely Challenged at Sentencing Phase

The penalty phase arises after the jury has found the defendant guilty of the capital crime. To help the jury determine whether a defendant should be sentenced to death, the State presents evidence of aggravating factors about the defendant and the crime, and the defense presents evidence of mitigating factors. The penalty phase presents the jury with "the moral and normative choice" of whether a capital defendant deserves execution.⁴⁷

PET scans are often admitted because criminal defendants facing the death penalty have a constitutional right to present any evidence at sentencing that could lead to a sentence less than death. In *Lockett v. Ohio* (1978), the Supreme Court determined that a capital defendant is entitled to present any aspect of character or record and any circumstance of the offense that might serve as a basis for a sentence less than death, regardless of whether the evidence supports a statutorily authorized mitigating factor.⁴⁸ And in *Tennard v. Dretke* (2004), the Supreme Court stated that any cognitive or neuropsychological impairment may be considered a mitigating factor even if the impairment bears no direct link with the homicidal behavior.⁴⁹ Evidence of a structural or metabolic brain abnormality could be included as evidence of a severe mental disturbance, a prong that most states and the federal government include as a mitigating factor in the death-penalty statute.⁵⁰ Further, most states allow a defendant to present any "other factor" in the defendant's background, record, or character or any other circumstance of the offense that mitigate against imposition of a death sentence.⁵¹ Evidence of brain damage or brain dysfunction can be offered under the "other factor" prong as well. Functional images of the brain are commonly admitted in death-penalty litigation to demonstrate brain abnormalities that a jury could find mitigating.⁵²

The admission of PET to demonstrate brain abnormalities has become routine during the penalty phase of capital trials in several states. The right to present a PET scan in the state of Florida was determined in *Hoskins v. State*.⁵³ Mr. Hoskins was charged with multiple felonies, including first-degree murder, and the State sought the death penalty.⁵⁴ Mr. Hoskins's examining physicians noted that he had an IQ of 71 and recom-

"The admission of PET to demonstrate brain abnormalities has become routine during the penalty phase of capital trials in several states."

43. *Id.* at 1165.

44. *United States v. Montgomery*, 635 F.3d 1074 (8th Cir. 2011).

45. *United States v. Mezvinsky*, 206 F. Supp. 2d 661 (E.D. Pa. 2002).

46. *Id.* at 674.

47. John H. Blume & Emily C. Paavola, *Life, Death, and Neuroimaging: The Advantages and Disadvantages of the Defense's Use of Neuroimaging in Capital Cases—Lessons from the Front*, 62 MERCER L. REV. 909, 914 (2011).

48. *Lockett v. Ohio*, 438 U.S. 586 (1978).

49. *Tennard v. Dretke*, 542 U.S. 274 (2004).

50. 18 U.S.C. § 3592. Mitigating and aggravating factors are to be con-

sidered in determining whether a sentence of death is justified.

51. *Id.*

52. O. Carter Snead, *Neuroimaging and the Courts: Standards and Illustrative Case Index, Emerging Issues in Neuroscience Conference for State and Federal Judges* (June 29, 2006), available at <http://www.ncsc.org/Conferences-and-Events/STC-seminar/~media/Files/PDF/Conferences%20and%20Events/AAA%20Neuroimaging%20and%20the%20Courts%20Standards%20and%20Illustrative%20Case%20Index.ashx>.

53. *Hoskins v. State*, 702 So. 2d 202, 209 (Fla. 1997).

54. *Id.*

“[T]he use of PET scans is growing, [and] some courts are now dealing with the question whether an attorney should be required to proffer a brain scan. . . .”

mended that PET be obtained as part of the workup for brain damage. The trial court refused to grant the defendant's motion seeking to transport Hoskins to a hospital for PET scanning. Mr. Hoskins was convicted of first-degree murder and sentenced to death. The appellate court remanded the case, ordering that a brain scan be obtained and a new penalty phase considered, in effect overturning Hoskins's death sentence.⁵⁵ The court's denial had limited the physician's ability to evaluate the

degree of Hoskins's mental impairment, which is a statutory mitigating factor under Florida law.⁵⁶

In most capital cases, the image of the defendant's brain is but one piece of evidence demonstrating the disadvantages confronted by the defendant. A complete mitigation workup will review the developmental, genetic, social, family, home environment, educational, and vocational history of the defendant. When evidence of brain damage or brain dysfunction has not been explored during the original sentencing phase of a capital trial, this oversight may be grounds for appeal.

INEFFECTIVE-ASSISTANCE-OF-COUNSEL CLAIMS FOR FAILURE TO EXPLORE BRAIN-BASED ABNORMALITIES

As explained in the previous section, it appears that the use of PET scans is growing, most rapidly in the sentencing phase of criminal trials. Accordingly, some courts are now dealing with the question whether an attorney should be required to proffer a brain scan in some contexts. This section reviews this emerging area of caselaw. While most of the time the use of a brain scan is not warranted, the illustrative cases raise the possibilities that in some circumstances, an attorney's failure to gather brain data would be ineffective assistance of counsel.

The U.S. Supreme Court established a two-part test for ineffective assistance of counsel in *Strickland v. Washington* (1984).⁵⁷ A case may be remanded if a criminal defendant can show that counsel's performance fell below an objective standard of reasonableness and that counsel's performance gave rise to a reasonable probability that, if counsel had performed adequately, the result of the trial or sentencing would have been different.⁵⁸

If an attorney fails to present mitigating evidence, including evidence of mental illness or extreme emotional distress, the case can be remanded for ineffective assistance of counsel. For example, California defendant Fernando Caro's death sentence was vacated and remanded for re-trial because his attorney

failed to investigate and present evidence of the impact that exposure to neurotoxicants and child abuse had on his brain.⁵⁹ The court stated that attorneys must cast a wide net for all relevant mitigating evidence at capital-sentencing hearings because “the Constitution prohibits imposition of the death penalty without adequate consideration of factors which might evoke mercy.”⁶⁰ The court did not state that neuroimaging was required in Caro's case. Rather, it gave an extensive list of circumstances that were likely to lead to brain damage. Caro spent his childhood working and playing in pesticide-soaked fields, and he bathed in and was fed food cooked in water contaminated with pesticides. The court noted that Caro worked as a “flagger” for a crop-dusting company and at a company that made toxic pesticides. He was regularly exposed to organophosphates, solvents, organochlorines, and carbamates, and he was poisoned by a number of toxic chemicals at the plant. In addition, Caro suffered serious physical abuse and head injuries as a result of horrific child abuse. Caro also sustained several head injuries as a child: he was born with a three-inch lump on his head due to the use of forceps during his difficult delivery, a water cooler fell on his head at the age of three, and he was hit by a car later that year.⁶¹

It is possible that testimony regarding these unfortunate circumstances would be adequate to allow a jury to sentence Caro to life rather than death. However, if a psychiatrist were to claim that these multiple neurologic insults caused brain damage, evidence of damage would need to be submitted to the court. The *Caro* court suggested that it is adequate for counsel to obtain a corroborated injury history listing factors that led to demonstrated cognitive impairment. But evidence could also be presented through neuropsychological testing, structural brain scans (MRI), and/or functional brain scans (SPECT or PET).

A California court also vacated a death sentence when an attorney failed to consult a neurologist, neuropsychologist, or psychiatrist regarding the defendant. In Francis Hernandez's case, the defense attorney failed to arrange a neurological exam of Hernandez despite the fact that he wrote notes in his legal file suggesting that he planned to do so. On appeal, the attorney stated that “evidence of neurological impairment is the type of evidence I wanted because it would have helped to explain and mitigate Francis's state of mind at the time of the killings.”⁶²

The United States Court of Appeals for the Tenth Circuit also determined that counsel's failure to present this evidence of brain-based abnormalities fell below the constitutional minimum standard for effective representation. Roderick Smith murdered his wife and four step-children. His defense counsel failed to present evidence of brain-based abnormalities including “borderline mental retardation, mental illness, and organic brain impairment” as mitigating evidence at trial.⁶³ The Tenth

55. *Id.*

56. FLA. STAT. § 921.141 (1995).

57. *Strickland v. Washington*, 466 U.S. 668 (1984).

58. *Id.*

59. *Caro v. Calderon*, 165 F.3d 1223, 1228 (9th Cir.), *cert. denied* 527 U.S. 1049 (1999).

60. *Id.* at 1227.

61. *Caro v. Woodford*, 280 F.3d 1247 (9th Cir.), *cert. denied* 536 U.S. 951 (2002).

62. *Hernandez v. Martel*, Acting Warden, California State Prison at San Quentin, CASE NO. CV 90-4638 RSWL (August 16, 2011).

63. *Smith v. Mullin*, 379 F.3d 919, 939 (10th Cir. 2004).

Circuit vacated his sentence, stating: “The sentencing stage is the most critical phase of a death penalty case. Any competent counsel knows the importance of thoroughly investigating and presenting mitigating evidence.”⁶⁴ We are cognizant of “the overwhelming importance of the role mitigation evidence plays in the just imposition of the death penalty.”⁶⁵

A brain scan does not replace a thorough mitigation analysis of a capital defendant, which should include the developmental, genetic, social, family, home environment, educational, and vocational history of the defendant. But evidence of brain deficit may arise from the mitigation analysis. If brain injury or intellectual deficit is suspected, defense counsel must have a qualified medical professional evaluate the defendant, and the professional may request neuropsychological testing. If physical examination or neuropsychological testing reveals brain-based deficits, these deficits may be confirmed or further characterized with brain imaging. The magnitude of the abnormality detected by neuropsychological testing can assist an expert in determining whether neuroimaging is likely to reveal brain-based abnormalities. In some cases, experts may recommend against obtaining costly brain images if they feel the abnormalities that could be pictorially displayed by the images will be minimal. In such cases, the prosecution is likely to draw attention to the lack of abnormality.

CONCLUSION

The inner workings of a defendant’s mind are often a central issue in each phase of criminal jurisprudence. However, different standards apply for admission of scientific evidence during the guilt phase and the penalty phase in criminal trials. In the pretrial phase, attorneys may request the evaluation of a criminal defendant for competence to stand trial. If a defendant is found incompetent to stand trial, the examiner is asked to give a diagnosis as to what caused the mental incapacity as well as a prognosis for when and how competence can be restored. In cases where a physician believes it will not be possible to restore a defendant’s mental wherewithal due to brain damage, a PET scan can help illustrate the brain-based abnormality that the examiner detected.

In the guilt phase of a criminal trial, PET may elucidate damage to areas of the brain that are involved in cognitive functions such as judgment and impulse control. Physicians may use PET to corroborate their clinical impression of a defendant. In some cases, prosecutors’ motions to exclude PET evidence that challenge defense experts’ plans to present a causal link between violence and brain damage have been successful.⁶⁶ But even in the face of evidentiary challenges, PET’s colorful imagery of brain damage can be useful during trial or in plea bargaining discussions, as in *Weinstein*.

At sentencing, brain-based deficits are a mitigating factor for both capital and non-capital defendants. While there is not yet an absolute mandate that brain-based deficits be considered in all criminal cases, the defendant’s cognitive and neuropsychological limitations must be considered in capital

cases, even if the impairment bears no direct link with the homicidal behavior.⁶⁷ Accordingly, when PET is offered as mitigating evidence during the sentencing phase of a capital murder trial, an admissibility challenge is unlikely. Failure to present evidence of brain damage has been a factor in overturning death sentences in ineffective-assistance-of-counsel cases. In addition, evidence of brain damage could assist a jury in understanding the defendant’s limitations, resulting in a lesser sentence.

When a judge has to decide whether to admit brain imaging, the rules of evidence provide clear guidelines regarding when and for what purposes such evidence can be introduced. The judge will consider whether the defense is offering the original scan or a comparison between the defendant’s scan and other scans. In cases where an extrapolation has occurred, the judge is the gatekeeper who must consider the reliability of the methodology used in the interpretation of the brain image. If scan methodology is determined to meet admissibility standards, then the judge will consider the reason why the scan is being offered. Before trial, does the information demonstrated by the scan assist the jury in determining the cognitive capacity of the criminal defendant? At the guilt phase, will the brain image assist the jury in deciding a fact at issue in the guilt-innocence phase of trial? Is there sufficient evidence to allow an expert to testify that a brain abnormality was related to violent or otherwise criminal behavior? During the sentencing phase, does the scan assist the judge or jury in understanding a particular deficit or disadvantage experienced by the defendant? In this final phase, brain images are almost always permitted to supplement the mitigation plea. In fact, in some cases not providing PET scans or other evidence of any brain abnormalities may be ineffective assistance of counsel.



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64. *Id.*

65. *Id.*

66. See Goldstein, 843 N.E.2d 727; Mezvinsky, 206 F. Supp. 2d 661;

Montgomery, 635 F.3d 1074.

67. Tennard, 542 U.S. 274 (2004).

Should the Science of Adolescent Brain Development Inform Public Policy?

Laurence Steinberg

The science of adolescent brain development is making its way into the national conversation. As an early researcher in the field, I regularly receive calls from journalists asking how the science of adolescent brain development should affect the way society treats teenagers. I have been asked whether this science justifies raising the driving age, outlawing the solitary confinement of incarcerated juveniles, excluding 18-year-olds from the military, or prohibiting 16-year-olds from serving as lifeguards on the Jersey Shore. Explicit reference to the neuroscience of adolescence is slowly creeping into legal and policy discussions as well as popular culture. The U.S. Supreme Court discussed adolescent brain science during oral arguments in *Roper v. Simmons*,¹ which abolished the juvenile death penalty, and cited the field in its 2010 decision in *Graham v. Florida*,² which prohibited the sentencing of juveniles convicted of crimes other than homicide to life without parole.

There is now incontrovertible evidence that adolescence is a period of significant changes in brain structure and function. Although most of this work has appeared just in the past 15 years, there is already strong consensus among developmental neuroscientists about the nature of these changes. And the most important conclusion to emerge from recent research is that important changes in brain anatomy and activity take place far longer into development than had been previously thought. Reasonable people may disagree about what these findings may mean as society decides how to treat young people, but there is little room for disagreement about the fact that adolescence is a period of substantial brain maturation with respect to both structure and function.

BRAIN CHANGES

There are four noteworthy, structural changes in the brain during adolescence. First, there is a decrease in gray matter in prefrontal regions of the brain, reflective of synaptic pruning, the process through which unused connections between neurons are eliminated. The elimination of these unused synapses occurs mainly during pre-adolescence and early adolescence, when major improvements in basic cognitive abilities and logical reasoning are seen, in part due to these very anatomical changes.

Second, important changes in activity involving the neurotransmitter dopamine occur during early adolescence, especially around puberty. There are substantial changes in the density and distribution of dopamine receptors in pathways that connect the limbic system and prefrontal cortex. The limbic system is associated with emotions, rewards, and punishments, and the prefrontal cortex is the brain's chief executive officer. There is more dopaminergic activity in the pathways that connect the two during the first part of adolescence than at any other time in development. Because dopamine plays a critical role in how humans experience pleasure, these changes have important implications for sensation-seeking.

Third, there is an increase in the strength of connections between the prefrontal cortex and the limbic system. If you were to compare a young teenager's brain with that of a young adult, you would see a much more extensive network of myelinated cables connecting brain regions. This anatomical change is especially important for emotion regulation, which is facilitated by increased connectivity between regions important in the processing of emotional information and those important in self-control. These connections permit different brain systems to communicate with each other more effectively, and these gains are also ongoing well into late adolescence.

Fourth, there is an increase in white matter in the prefrontal cortex during adolescence. This is largely the result of myelination, the process through which nerve fibers become sheathed in myelin, a white, fatty substance that improves the efficiency of brain circuits. Unlike the synaptic pruning of the prefrontal areas, which is mainly finished by mid-adolescence, myelination continues well into late adolescence and early adulthood. This increased efficiency in neural connections within the prefrontal cortex is important for higher-order cognitive functions—planning ahead, weighing risks and rewards, and making complicated decisions, among others—that are regulated by multiple prefrontal areas working in concert.

Adolescence is not just a time of tremendous change in the brain's structure. It is also a time of important changes in how the brain works, as revealed in studies using functional magnetic resonance imaging, or fMRI. What do these imaging studies reveal about the adolescent brain? First, over the course of adolescence and into early adulthood, there is a

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Footnotes

1. 543 U.S. 551 (2005).
2. 560 U.S. 48 (2010).

strengthening of activity in brain systems involving self-regulation. During tasks that require self-control, adults employ a wider network of brain regions than do adolescents, and this trait may make self-control easier, by distributing the work across multiple areas of the brain rather than overtaxing a smaller number of regions.

Second, there are important changes in the way the brain responds to rewards. When one examines brain scans of individuals who are shown rewarding stimuli, such as piles of coins or pictures of happy faces, adolescents' reward centers are usually activated more than children's or adults' brains. (Interestingly, these age differences are more consistently observed when individuals are anticipating rewards than when they are receiving them.) Heightened sensitivity to anticipated rewards motivates adolescents to engage in risky acts when the potential for pleasure is high, such as with unprotected sex, fast driving, or experimentation with drugs. In our laboratory, Jason Chein and I have shown that this hypersensitivity to reward is particularly pronounced when adolescents are with their friends, and we think this helps explain why adolescent risk-taking so often occurs in groups.³

A third change in brain function over the course of adolescence involves increases in the simultaneous involvement of multiple brain regions in response to arousing stimuli, such as pictures of angry or terrified faces. Before adulthood, there is less cross-talk between the brain systems that regulate rational decision-making and those that regulate emotional arousal. During adolescence, very strong feelings are less likely to be modulated by the involvement of brain regions involved in controlling impulses, planning ahead, and comparing the costs and benefits of alternative courses of action. This is one reason why susceptibility to peer pressure declines as adolescents grow into adulthood; as they mature, individuals become better able to put the brakes on an impulse that is aroused by their friends.

IMPORTANCE OF TIMING

These structural and functional changes do not all take place along one uniform timetable, and the differences in their timing raise two important points relevant to the use of neuroscience in public policy. First, there is no simple answer to the question of when an adolescent brain becomes an adult brain. Brain systems implicated in basic cognitive processes reach adult levels of maturity by mid-adolescence, whereas those that are active in self-regulation do not fully mature until late adolescence or even early adulthood. In other words, adolescents mature intellectually before they mature socially or emotionally, a fact that helps explain why teenagers who are so smart in some respects sometimes do surprisingly dumb things.

To the extent that society wishes to use developmental neuroscience to inform public policy decisions on where to draw age boundaries between adolescence and adulthood, it is

important to match the policy question with the right science. In his dissenting opinion in *Roper*, the juvenile-death-penalty case, Justice Antonin Scalia criticized the American Psychological Association, which submitted an amicus brief arguing that adolescents are not as mature as adults and therefore should not be eligible for the death penalty. As Scalia pointed out, the association had previously taken the stance that adolescents should be permitted to make decisions about abortion without involving their parents, because young people's decision-making is just as competent as that of adults.

The association's two positions may seem inconsistent at first glance, but it is entirely possible that an adolescent might be mature enough for some decisions but not others. After all, the circumstances under which individuals make medical decisions and commit crimes are very different and make different sorts of demands on their brains and abilities. State laws governing adolescent abortion require a waiting period before the procedure can be performed, as well as consultation with an adult—a parent, health care provider, or judge. These policies discourage impetuous and shortsighted acts and create circumstances under which adolescents have been shown to be just as competent at making decisions as adults. In contrast, violent crimes are usually committed by adolescents when they are emotionally aroused and with their friends—two conditions that increase the likelihood of impulsivity and sensation-seeking and that exacerbate adolescent immaturity. From a neuroscientific standpoint, it therefore makes perfect sense to have a lower age for autonomous medical decision-making than for eligibility for capital punishment, because certain brain systems mature earlier than others.

There is another kind of asynchrony in brain development during adolescence that is important for public policy. Middle adolescence is a period during which brain systems implicated in how a person responds to rewards are at their height of arousability but systems important for self-regulation are still immature. The different timetables followed by these different brain systems create a vulnerability to risky and reckless behavior that is greater in middle adolescence than before or after. It's as if the brain's accelerator is pressed to the floor before a good braking system is in place. Given this, it is no surprise that criminal activity peaks around age 17—as does first experimentation with alcohol and marijuana, automobile crashes, accidental drownings, and attempted suicide.

In sum, the consensus emerging from recent research on the adolescent brain is that teenagers are not as mature as adults in either brain structure or function. This does not mean that adolescents' brains are "defective," just as newborns' muscular systems, which do not allow them to walk, or language systems, which do not allow them to carry on conversations, are

“[T]here is no simple answer to the question of when an adolescent brain becomes an adult brain.”

3. Jason Chein et al., *Peers Increase Adolescent Risk Taking by Enhancing Activity in the Brain's Reward Circuitry*, 14(2) DEVELOPMENTAL SCI. F1(2011).

“[Adolescence] is a time when people are, on average, not as mature as they will be in adulthood.”

not defective. The fact that the adolescent brain is still developing, and in this regard is less mature than the adult brain, is normative, not pathological. Adolescence is a developmental stage, not a disease, mental illness, or defect. But it is a time when people are, on average, not as mature as they will be in adulthood.

I am frequently asked how to reconcile this view of adolescence with historical evidence that adolescents successfully performed adult roles in previous eras. This may be true, but all societies in recorded history have recognized a period of development between childhood and adulthood, and writers as far back as Aristotle have characterized adolescents as less able to control themselves and more prone to risk-taking than adults. In 1623 (without the benefit of brain scans), Shakespeare wrote in *The Winter's Tale*: “I would there were no age between ten and three-and-twenty, or that youth would sleep out the rest; for there is nothing in the between but getting wenches with child, wronging the ancients, stealing, fighting.”

SCIENCE IN THE POLICY ARENA

Although there is a good degree of consensus among neuroscientists about many of the ways in which brain structure and function change during adolescence, it is less clear just how informative this work is about adolescent behavior for public policy. Because all behavior must have neurobiological underpinnings, it is hardly revelatory to say that adolescents behave the way they do because of “something in their brain.” Moreover, society hardly needs neuroscience to tell it that, relative to adults, adolescents are more likely to engage in sensation seeking, less likely to control their impulses, or less likely to plan ahead. So how does neuroscience add to society's understanding of adolescent behavior? What is the value, other than advances in basic neuroscience, of studies that provide neurobiological evidence that is consistent with what is already known about human behavior?

I will consider five such possibilities, two that I think are valid, two that I think are mistaken, and one where my assessment is equivocal. Let me begin with two rationales that are widely believed but that are specious.

The first mistake is to interpret age differences in brain structure or function as conclusive evidence that certain behaviors must be hard-wired. A correlation between brain development and behavioral development is just that: a correlation. It says nothing about the causes of the behavior or about the relative contributions of nature and nurture. In some cases, the behavior may indeed follow directly from biologically driven changes in brain structure or function. But in others, the reverse is true—that is, the observed brain change is the consequence of experience. Yes, adolescents may develop better impulse control as a result of changes within the prefrontal cortex, and it may be true that these anatomical changes are programmed to unfold along a predetermined timetable. But it is also plausible that the structural changes observed in the prefrontal cortex result from experiences that

demand that adolescents exercise self-control, in much the same way that changes in muscle structure and function often follow from exercise.

A second mistake is assuming that the existence of a biological correlate of some behavior demonstrates that the behavior cannot be changed. It is surely the case that some of the changes in brain structure and function that take place during adolescence are relatively impervious to environmental influence. But the brain is malleable, and there is a good deal of evidence that adolescence is, in fact, a period of especially heightened neuroplasticity. That's one reason it is a period of such vulnerability to many forms of mental illness.

I suspect that the changes in reward sensitivity that I described earlier are largely determined by biology and, in particular, by puberty. I say this because the changes in reward seeking observed in young adolescents are also seen in other mammals when they go through puberty. This makes perfect sense from an evolutionary perspective because adolescence is the period during which mammals become sexually active, a behavior that is motivated by the expectation of pleasure. An increase in reward sensitivity soon after puberty is added insurance that mammals will do what it takes to reproduce while they are at the peak of fertility, including engaging in a certain amount of risky behavior, such as leaving the nest or troop to venture out into the wild. In fact, the age at peak human fecundity (that is, the age at which an individual should begin having sex if he or she wants to have the most children possible) is about the same as the age at the peak of risk-taking—between 16 and 17 years of age.

Other brain changes that take place during adolescence are probably driven to a great extent by nurture and may therefore be modifiable by experience. There is growing evidence that the actual structure of prefrontal regions active in self-control can be influenced by training and practice. So in addition to assuming that biology causes behavior, and not the reverse, it is also a mistake to think that the biology of the brain cannot be changed.

HOW SCIENCE CAN HELP

How, then, does neuroscience contribute to a better understanding of adolescent behavior? As I said, I think the neuroscience serves at least two important functions.

First, neuroscientific evidence can provide added support for behavioral evidence when the neuroscience and the behavioral science are conceptually and theoretically aligned. Notice that I used the word “support” here. When neuroscientific findings about adolescent brain development are consistent with findings from behavioral research, the neuroscience provides added confidence in the behavioral findings; scientific evidence of any sort is always more compelling when it has been shown to be valid. But it is incorrect to privilege the neuroscientific evidence over the behavioral evidence, which is frequently done because the neuroscientific evidence is often incorrectly assumed to be more reliable, precise, or valid. Many nonscientists are more persuaded by neuroscience than by behavioral science, because they often lack the training or expertise that would enable them to view the neuroscience through a critical lens. In science, familiarity breeds skepticism, and the lack of knowledge that most laypersons have

about the workings of the brain, much less the nuances of neuroscientific methods, often leads them to be overly impressed by brain science and underwhelmed by behavioral research, even when the latter may be more relevant to policy decisions.

A second way in which neuroscience can be useful is that it may help generate new hypotheses about adolescent development that can then be tested in behavioral studies. This is especially important when behavioral methods cannot be used to test alternative accounts of a phenomenon. Let me illustrate this point with an example from our ongoing research.

As I noted earlier, it has been hypothesized that heightened risk-taking in adolescence is thought to be the product of an easily aroused reward system and an immature self-regulatory system. The arousal of the reward system takes place early in adolescence and is closely tied to puberty, whereas the maturation of the self-regulatory system is independent of puberty and unfolds gradually, from preadolescence through young adulthood.

In our studies, we have shown that reward sensitivity, preference for immediate rewards, sensation-seeking, and a greater focus on the rewards of a risky choice all increase between preadolescence and mid-adolescence, peak between ages 15 and 17, and then decline.⁴ In contrast, controlling impulses, planning ahead, and resisting peer influence all increase gradually from pre-adolescence through late adolescence, and in some instances, into early adulthood.

Although one can show without the benefit of neuroscience that the inclination to take risks is generally higher in adolescence than before or after, having knowledge about the course of brain development provides insight into the underlying processes that might account for this pattern. We've shown in several experiments that adolescents take more risks when they are with their friends than when they are alone. But is this because the presence of peers interferes with self-control or because it affects the way in which adolescents experience the rewards of the risky decision? It isn't possible to answer this question by asking teenagers why they take more risks when their friends are around. They admit that they do, but they say they do not know why. But through neuroimaging, we discovered that the peer effect was specifically due to the impact that peers have on adolescents' reward sensitivity. Why does this matter? Because if the chief reason that adolescents experiment with tobacco, alcohol, and other drugs is that they are at a point in life where everything rewarding feels especially so, trying to teach them to "Just Say No" is probably futile. I have argued elsewhere that raising the price of cigarettes and alcohol, thereby making these rewarding substances harder to obtain, is probably a more effective public policy than health education.⁵

I have now described two valid reasons to use neuroscience to better understand adolescent behavior and two questionable

ones. I want to add a fifth, which concerns the attributions we make about individuals' behavior. This particular use of neuroscience is having a tremendous impact on criminal law.

A few years ago I was asked to provide an expert opinion in a Michigan case involving a prison inmate named Anthony, who as a 17-year-old was part of a group of teenagers who robbed a small store. During the robbery, one of the teenagers shot and killed the storekeeper. Although the teenagers had planned the robbery, they did not engage in the act with the intention of shooting, much less murdering, someone. But under the state's criminal law, the crime qualified as felony murder, which in Michigan carries a mandatory sentence of life without the possibility of parole for all members of the group involved in the robbery—including Anthony, who had fled the store before the shooting took place.

Anthony—who has been in prison for 33 years—requested that his sentence be vacated in light of the Supreme Court's ruling in *Graham v. Florida* that life without parole is cruel and unusual punishment for juveniles because they are less mature than adults.⁶ The ruling in that case was limited to crimes other than homicide, so Anthony's challenge was based on the argument that the logic behind the *Graham* decision applies to felony murder as well.

I was asked specifically whether a 17-year-old could have anticipated that someone might be killed during the robbery. It is quite clear from the trial transcript that Anthony didn't anticipate this consequence, but "didn't" is not the same as "couldn't." It is known from behavioral research that the average 17-year-old is less likely than the average adult to think ahead, control his impulses, and foresee the consequences of his actions, and clinical evaluations of Anthony revealed that he was a normal 17-year-old. But "less likely" means just that; it doesn't mean "unable," but neither does it mean "unwilling." As I will explain, the distinction between "didn't" and "couldn't" is important under the law. And studies of adolescent brain development might be helpful in distinguishing between the two.

The issue was not whether Anthony is guilty. He freely admitted having participated in the robbery, and there was clear evidence that the victim was shot and killed by one of the robbers. But even when someone is guilty, many factors can influence the sentence he receives. Individuals who are deemed less than fully responsible are punished less severely than those who are judged to be fully responsible, even if the

"We've shown in several experiments that adolescents take more risks when they are with their friends than when they are alone."

4. E.g., Chein et al, *supra* note 3; Laurence Steinberg, *A Social Neuroscience Perspective on Adolescent Risk-Taking*, 28 *DEVELOPMENTAL REV.* 78–106; Laurence Steinberg, et al., *Age Differences in Sensation Seeking and Impulsivity as Indexed by Behavior and Self-Report: Evidence for a Dual Systems Model*, 44 *DEVELOPMENTAL PSYCHOL.* 1764 (2008).

5. Laurence Steinberg, *Risk Taking in Adolescence: What Changes, and Why?*, 1021 *ANNALS N.Y. ACAD. SCI.* 51 (2004).

6. See also *Miller v. Alabama*, 132 S. Ct. 2455 (2012) (even for the crime of murder, mandatory sentences of life without the possibility of parole are unconstitutional).

“. . . I have argued that adolescents should be viewed as inherently less responsible than adults and should be punished less harshly than adults, even when their crimes are identical.”

consequences of the act are identical. For example, manslaughter is not punished as harshly as premeditated murder, even though both result in the death of another individual. So the question in Anthony's case, as it was in the *Roper* and *Graham* Supreme Court cases, was whether 17-year-olds are fully responsible for their behavior. If they are not, they should not be punished as severely as individuals whose responsibility is not diminished.

In order for something to diminish criminal responsibility, it has to be something that was not the person's fault—that was outside his control. If someone

has an untreatable tumor on his frontal lobe that is thought to make him unable to control aggressive outbursts, he is less than fully responsible for his aggressive behavior, and the presence of the tumor would be viewed as a mitigating factor if he were being sentenced for a violent crime. On the other hand, if someone with no neurobiological deficit goes into a bar, drinks himself into a state of rage, and commits a violent crime as a result, the fact that he was drunk does not diminish his responsibility for his act. It doesn't matter whether the mitigating factor is biological, psychological, or environmental. The issue is whether the diminished responsibility is the person's fault and whether the individual could have been able to compensate for whatever it is that was uncontrollable.

Judgments about mitigation are often difficult to make because most of the time, factors that diminish responsibility fall somewhere between the extremes of things that are obviously beyond an individual's control, such as brain tumors, and those that an individual could have controlled, such as self-inflicted inebriation. In many cases, things are not clear-cut. One must make a judgment call, and one looks for evidence that tips the balance in one direction or the other. Profound mental retardation that compromises foresight is a mitigating condition. A lack of foresight as a result of stupidity that is within the normal range of intelligence is not. Being forced to commit a crime because a gun is pointed at one's head mitigates criminal responsibility. Committing a crime in order to save face in front of friends who have made a dare does not. Many things can lead a person to act impulsively or without foresight but are not necessarily mitigating. A genetic inclination toward aggression is probably in this category, as is having been raised in a rotten neighborhood. Both are external forces, but society does not see them as so determinative that they automatically diminish personal responsibility.

As I have argued elsewhere,⁷ studies of adolescent brain anatomy clearly indicate that regions of the brain that regulate such things as foresight, impulse control, and resistance to peer pressure are still developing at age 17. Imaging studies show that immaturity in these regions is linked to adolescents' poorer performance on tasks that require these capabilities. There is evidence that the adolescent brain is less mature than the adult brain in ways that affect some of the behaviors that mitigate criminal responsibility. This suggests that at least some of adolescents' irresponsible behavior is not entirely their fault.

The brain science, in and of itself, does not carry the day, but when the results of behavioral science are added to the mix, I think it tips the balance toward viewing adolescent impulsivity, short-sightedness, and susceptibility to peer pressure as developmentally normative phenomena that teenagers cannot fully control. This is why I have argued that adolescents should be viewed as inherently less responsible than adults and should be punished less harshly than adults, even when their crimes are identical.⁸ I do not find persuasive the counterargument that some adolescents can exercise self-control or that some adults are just as impulsive and shortsighted as teenagers. Of course there is variability in brain function and behavior among adolescents, and of course there is variability among adults. But the average differences between the age groups are significant, and that is what counts as society draws age boundaries under the law on the basis of science.

AGE RANGES FOR RESPONSIBILITY

Beyond criminal law, how should social policy involving young people take this into account? Society needs to distinguish between people who are ready for the rights and responsibilities of adulthood and those who are not. Science can help in deciding where best to draw the lines. Based on what is now known about brain development—and I say “now known” because new studies are appearing every month—it is reasonable to posit that there is an age range during which adult neurobiological maturity is reached. Framing this as an age range, rather than pinpointing a discrete chronological age, is useful because doing so accommodates the fact that different brain systems mature along different timetables, and different individuals mature at different ages and rates. The lower bound of this age range is probably somewhere around 15, and the upper bound is probably somewhere around 22. By this I mean that if society had an agreed-upon measure of adult neurobiological maturity (which it doesn't yet have but may at some point in the future), it would be unlikely that many normally developing individuals would have attained this mark before turning 15 and would have failed to reach it by age 22.

If society were to choose either of these endpoints as the age of majority, it would be forced to accept many errors of classification because granting adult status at age 15 would result in treating many immature individuals as adults, which is dan-

7. Laurence Steinberg, *Should the Science of Adolescent Brain Development Inform Public Policy?*, 64 AM. PSYCHOLOGIST 739 (2009).

8. Elizabeth S. Scott & Laurence Steinberg, *RETHINKING JUVENILE JUSTICE* (2008); Elizabeth Cauffman & Laurence Steinberg, *(Im)matu-*

rity of Judgment in Adolescence: Why Adolescents May Be Less Culpable than Adults, 18 BEHAV. SCI. & L. 741 (2000); Laurence Steinberg, *Adolescent Development and Juvenile Justice*, 5 ANN. REV. CLINICAL PSYCHOL. 47 (2009).

gerous, whereas waiting until age 22 would result in treating many mature individuals as children, which is unjust. So what is society to do? I think there are four possible options.

The first option is to pick the mid-point of this range. Yes, this would result in classifying some immature individuals as adults and some mature ones as children. But this would be true no matter what chronological age is picked, and assuming that the age of neurobiological maturity is normally distributed, fewer errors would be made by picking an age near the middle of the range than at either of the extremes. Doing so would place the dividing line somewhere around 18, which, it turns out, is the presumptive age of majority pretty much everywhere around the world. In the vast majority of countries, 18 is the age at which individuals are permitted to vote, drink, drive, and enjoy other adult rights. And just think—the international community arrived at this without the benefit of brain scans.

A second possibility would be to decide, on an issue-by-issue basis, what it takes to be “mature enough.” Society does this regularly. Although the presumptive age of majority in the United States is 18, the nation deviates from this age more often than not. Consider, for a moment, the different ages mandated for determining when individuals can make independent medical decisions, drive, hold various types of employment, marry, view R-rated movies without an adult chaperone, vote, serve in the military, enter into contracts, buy cigarettes, and purchase alcohol. The age of majority with respect to these matters ranges from 15 to 21, which is surprisingly reasonable, given what science says about brain development. The only deviation I can think of that falls out of this range is the nation’s inexplicable willingness to try people younger than 15 as adults, but this policy, in part because of the influence of brain science, is now being questioned in many jurisdictions.

Although the aforementioned age range may be reasonable, society doesn’t rely on science to link specific ages to specific rights or responsibilities, and some of the nation’s laws are baffling, to say the least, when viewed through the lens of science or public health. How is it possible to rationalize permitting teenagers to drive before they are permitted to see R-rated movies on their own, sentencing juveniles to life without parole before they are old enough to serve on a jury, or sending young people into combat before they can buy beer? The answer is that policies that distinguish between adolescents and adults are made for all sorts of reasons, and science, including neuroscience, is only one of many proper considerations.

A third possibility would be to shift from a binary classification system, in which everyone is legally either a child or an adult, to a regime that uses three legal categories: one for children, one for adolescents, and one for adults. The nation does this for some purposes under the law now, although the age boundaries around the middle category aren’t necessarily scientifically derived. For example, many states have graduated drivers’ licensing, a system in which adolescents are permitted

to drive but are not granted full driving privileges until they reach a certain age. This model also is used in the construction of child labor laws, where adolescents are allowed to work once they’ve reached a certain age, but there are limits on the types of jobs they can hold and the numbers of hours they can work.

In our book, *Rethinking Juvenile Justice*,⁹ Elizabeth Scott and I have argued that this is how the nation should structure the justice system, treating adolescent offenders as an intermediate category, neither as children, whose crimes society excuses, nor as adults, whom society holds fully responsible for their acts. While there are some areas of the law where a three-way system would be difficult to imagine, such as voting, it has been suggested that society should apply this model to other areas of the law. For example, we could permit individuals between 18 and 20 to purchase beer and wine, but not hard liquor, and implement especially stiff punishment for adolescents who become intoxicated or engage in wrongdoing under the influence of alcohol.

A final possibility is acknowledging that there is variability in brain and behavioral development among people of the same chronological age and making individualized decisions, rather than drawing categorical age boundaries at all. Many of the Supreme Court justices who dissented in the juvenile-death-penalty and life-without-parole cases took this stance. They argued that instead of treating adolescents as a class of individuals who are too immature to be held fully responsible for their behavior, the policy should be to assess each offender’s maturity to determine his criminal culpability. The justices did not specify what tools would be needed to do this, however, and reliably assessing psychological maturity is easier said than done. There is a big difference between using neuroscience to guide the formulation of policy and using it to determine how individual cases are adjudicated. Although it may be possible to say that, on average, people who are Johnny’s age are typically less mature than adults, we cannot say whether Johnny himself is.

Science may someday have the tools to image an adolescent’s brain and draw conclusions about that individual’s neurobiological maturity relative to established age norms for various aspects of brain structure and function, but such norms do not yet exist, and the cost of doing individualized assessments of neurobiological maturity would be prohibitively expensive. Moreover, it is not clear that society would end up making better decisions using neurobiological assessments than those it makes on the basis of chronological age or than

“There is a big difference between using neuroscience to guide the formulation of policy and using it to determine how individual cases are adjudicated.”

9. *Supra* note 8.

those it might make using behavioral or psychological measures. It makes far more sense to rely on a driving test than a brain scan to determine whether someone is ready to drive. So don't expect to see brain scanners any time soon at your local taverns or movie theaters.

ACCEPTING THE CHALLENGES

The study of adolescent brain development has made tremendous progress in the very short period that scientists have been studying the adolescent brain systematically. As the science moves ahead, the big challenge facing those of us who want to apply this research to policy will be in understanding the complicated interplay of biological maturation and environmental influence as they jointly shape adolescent behavior. And this can be achieved only through collaboration between neuroscientists and scholars from other disciplines. Brain science should inform the nation's policy discussions when it is relevant, but society should not make policy decisions on the basis of brain science alone.

Whether the revelation that the adolescent brain may be less mature than scientists had previously thought is ultimately a good thing, a bad thing, or a mixed blessing for young people remains to be seen. Some policymakers will use this evidence to argue in favor of restricting adolescents' rights, and others will use it to advocate for policies that protect adolescents from harm. In either case, scientists should welcome the opportunity to inform policy discussions with the best available empirical evidence.



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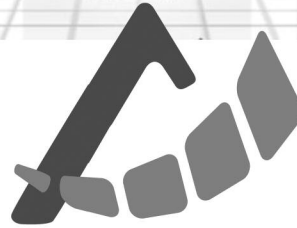
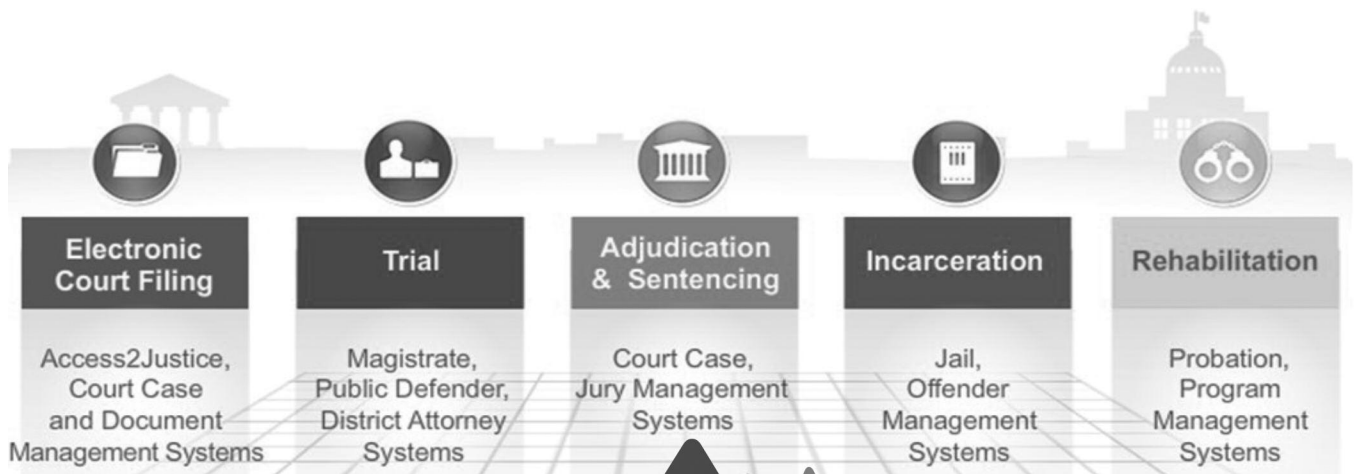
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Pain as Fact and Heuristic:

How Pain Neuroimaging Illuminates Moral Dimensions of Law

Amanda C. Pustilnik

Important legal distinctions turn on the presence and degree of physical pain. Statutes refer to degrees of physical pain to define criminal offenses like torture-murder,¹ while pain that rises to the level of cruelty draws the boundary between constitutionally permissible and impermissible punishment.² Claims about pain motivate legislative action to protect previously unrecognized classes, such as in several states' recent passage of statutes concerning fetal pain and fetal anesthesia during abortion.³ In legal domains ranging from tort to torture, pain and its degree do important definitional work by establishing boundaries of lawfulness and of entitlements.

For all of the work done by pain as a term in statutes, treaties, constitutions, and administrative- and common-law jurisprudence, it has had a troubling lack of externally verifiable reality.⁴ Like other subjective, affective states, pain has been invisible and, frequently, unspeakable.⁵ Though we have been able to impute pain based on experience or knowledge or by observing expressions of it in behavior, we have not been able to observe or measure it directly.⁶ For this reason, claims of great pain come with great doubt.

But now, pain rests on the cusp of visibility. That is, neuroimaging technology is in the process of making pain, anxiety, certain forms of deception, and potentially myriad other subjective states at least partly knowable and quantifiable. This article, which is part of a broader project exploring the role of pain imaging in law, argues that statutory definitions of chronic pain and judicial interpretations both of such statutes and of evidence presented by chronic-pain claimants must be updated to reflect recent discoveries that various chronic-pain syndromes constitute verifiable and distinct neurological disorders.

Assessing the impact that the neuroimaging of pain may have on diverse areas of law illuminates the point that legal issues concerning the body rarely assume the form of straightforward questions about physical facts or measurement. Though they may involve measurement, they also fundamentally implicate the normative dimension of how suffering relates to empathy and of who deserves (or does not deserve) empathy in the law. Indeed, pain discourse in law frequently is a proxy or heuristic for values and for moral or normative judgments. Attempting to solve certain normatively freighted legal problems, like what constitutes torture, or cruel and unusual punishment, through quantification would be profoundly misguided. There are serious empirical and epistemic questions as

to whether even perfect pain quantification could modify or improve ostensibly pain-related areas of legal doctrine. This is not because the technology is not “there yet” (although it is not) but more fundamentally because certain doctrinal legal issues presented as pain-measurement problems are predominantly values problems—problems about whose suffering counts and how much suffering we will tolerate to be inflicted upon or experienced by different categories of persons.

It is not accidental that pain functions as a moral status indicator; rather, this stems from the unique relationship between pain and empathy. Our conceptions of rights and duties are necessarily informed by human physicality and constrained by the limits of empathic identification. A person's moral proscription against excess pain ends when that person encounters the boundaries of empathic identification—the ability to say that a category of subjects is in some way “like us.”⁷ This helps explain why different groups can hold incompatible intuitions about whether the infliction of excess pain constitutes a wrong, separate even from the infliction of death, in such disparate and morally contentious areas as the death penalty, pre-viability abortion, and animal welfare. Pain measurement thus represents the archetypal example of how to properly understand if, when, and how to adapt the findings of brain imaging to bodies of legal doctrine. Attempts to resolve values-laden issues with neuroimaging or other forms of hedonic quantification would suffer from a measurement fallacy; this would in turn produce policy prescriptions as morally unconvincing as they would be practically infeasible.

This article proceeds in four parts. Part I describes the biology of pain and the science of pain detection, focusing on functional magnetic resonance imaging (fMRI) for the detection of acute pain. It incorporates current medical and scientific research and interviews with leading pain researchers in the United States and United Kingdom who offer their views on the potential and limits of pain detection. This part contends that, while stunning advances have occurred in neuroimaging, current and in-principle barriers to accurate pain measurement remain.

Part II presents the first of two case studies. It analyzes criminal torture-murder statutes (with related caselaw) and then analyzes state torture statutes and treaties, both of which facially speak in terms of quanta of pain. As part II will show, torture-murder and state torture function as an expressive designation for the categories of offenses that are most norma-

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Footnotes

1. See, e.g., IDAHO CODE ANN. § 18-4001 (2004).
2. See *Baze v. Rees*, 553 U.S. 35, 47-48 (2008) (plurality opinion) (summarizing caselaw stating that execution methods imposing

more pain than is required to cause death would violate the Eighth Amendment bar on cruel and unusual punishments).

3. Robert M. Cover, *Violence and the Word*, 95 YALE L.J. 1601, 1601 (1986) (footnote omitted).
4. See *id.* at 3.
5. See *id.* at 3-4.
6. See *id.* at 7.
7. Cf. ELAINE SCARRY, *THE BODY IN PAIN: THE MAKING AND UNMAKING OF THE WORLD* 3-4 (1985) (describing a person's reaction to pain as retaining inherently personal aspects).

tively transgressive. Consistent with liberal political theory, the harm, although tied to the body, primarily lies in the expression of corrupt values relative to the autonomy and personhood of the victim.

Part III presents a second set of case studies that examine the role of pain in Eighth Amendment challenges to execution by lethal injection and in recent legislation restricting late-term abortion. In these areas, advocates who oppose state execution or abortion frame their challenges to the contested practices as challenges to excess physical suffering—that the state should neither inflict nor countenance the infliction of suffering on the condemned or the unborn. However, despite their anti-pain rhetoric, important normative commitments independent of objections to physical pain animate activists who work in these areas.

Part IV draws on the insights from the case studies to develop the concept of embodied morality: the idea that facts about the body do not translate directly into legal conclusions or concepts but do inform a community's norms about what constitutes morally permissible treatment of the body. Pain's role across different areas of law thus provides a fascinating lens through which to understand legal notions of the embodied person and its normative dimensions.

I. PAIN AND PAIN IMAGING: A BRIEF INTRODUCTION

A. ACUTE PAIN: DEFINITION AND MECHANISMS

1. Definition and Basic Mechanisms of Acute Pain

Acute pain is the pain that a person experiences immediately when something goes wrong. Such pain results from the brain's translation of signals it receives from the body's contact with a noxious external stimulus, like a hot stove, or from a sudden change in the body's internal condition, like intestinal cramps. Acute pain is characterized not by its severity but by its suddenness and short duration. Although there exists a common vernacular misuse of "acute pain" to mean "very severe pain," acute pain may indeed be only minor or moderate. For example, the pain of getting a paper cut and of breaking a leg are both acute, but the former is minor while the latter is severe. Acute pain is the basic pain model and is also a highly impor-

tant survival mechanism that motivates the sufferer to get away from the harmful thing.⁸

Regardless of where pain originates in the body, the brain acts as the central processing unit for pain. The pain-detecting nerves present in the part of the body that encounters the noxious stimulus send the message to the brain through ascending or "afferent" neurons. The brain interprets the signal and then sends signals back via descending or "efferent" neurons to where the afferent signal originated. The signal from the brain back to the peripheral site can be amped up or tamped down by descending modulation. That is, the body's physiological state (including mental state) can both magnify and moderate the pain signal.⁹

Although we often think of pain as being instantaneous and "in" a particular body part, it is possible to demonstrate in a few ways that pain is actually not "in" the place that feels hurt. One classic example is the experience of pain in body parts that no longer exist: so-called phantom limb pain. That phenomenon may cause pain in a missing hand that feels exactly like pain in a physically present hand.¹⁰ Conversely, if signaling to the brain has been blocked, a noxious stimulus applied to the physically present hand will produce no pain at all.¹¹

Thus, there is no simple one-to-one relationship between harm to the peripheral site, signal strength up to the brain, efferent signal strength back down to the site, and pain perception.¹² The brain's reception and interpretation of the afferent signal is essential for the brain's detection of and response to aversive stimuli, but pain perception requires something more.¹³ The brain must receive and interpret the afferent signal and operationalize conscious awareness of the signal.¹⁴

2. The Role of Consciousness in Pain

Without consciousness, there is no pain. Consider the case of a person who is anaesthetized with general anesthesia for a surgical procedure. Anesthesia renders the person unconscious;¹⁵

"Although we often think of pain as being instantaneous and 'in' a particular body part, [sometimes] pain is actually not 'in' the place that feels hurt."

8. See *Pain Management Basics*, WEBMD, <http://www.webmd.com/pain-management/guide/pain-basics>; see also *FAQs: What Is Pain?* THE BRITISH PAIN SOC'Y, http://www.britishpainsociety.org/patient_faq.htm#q1.

9. See *FAQs: What Is Pain?* *supra* note 8; *The Autonomic Nervous System*, NAT'L DYSAUTONOMIA RES. FOUND., <http://www.ndrf.org/ans.html>.

10. See *Phantom Pain: Definition*, MAYO CLINIC, <http://www.mayoclinic.org/diseases-conditions/phantom-pain/basics/definition/con-20023268>; see also OLIVER SACKS, *THE MAN WHO MISTOOK HIS WIFE FOR A HAT* 66–70 (1985) (recounting a patient who had damaged proprioception that caused him to lose his sense of balance).

11. This is the mechanism through which local anesthetics like bupivacaine work: by flooding the sodium channels in the nerve fibers around where it is injected, the anesthetic blocks the nerves from transmitting signals up to the brain. See STEPHEN E. ABRAM, *PAIN MEDICINE: THE REQUISITES IN ANESTHESIOLOGY* 91–93 (2006) (describing bupivacaine and other sensory-blocking

local anesthetics).

12. *Id.* at 12–13 (describing descending control in nociception and pain).

13. *Id.* at 28.

14. A conscious person may experience no pain if nerve signaling from the site of injury to the spinal cord or brain has been blocked. This is the mechanism by which local anesthetic and epidurals work. See *supra* note 21 and accompanying text; see also, e.g., C. Richard Chapman, *Pain Perception, Affective Mechanisms, and Conscious Experience*, in *PAIN: PSYCHOLOGICAL PERSPECTIVES* 59, 59–60 (Thomas Hadjistavropoulos & Kenneth D. Craig eds., 2004).

15. Contrast this with the description of a nerve block injection, see *supra* note 11, which prevents signal transmission from the nerve to the brain. General anaesthesia does not block afferent signal transmission; rather, "[t]he anesthetized brain doesn't respond to pain signals or surgical manipulations." *General Anesthesia: Definition*, MAYO CLINIC, <http://www.mayoclinic.org/tests-procedures/anesthesia/basics/definition/prc-20014786>.

“This section describes the brain regions involved in pain processes and the fMRI research correlating brain activation with subjective experience.”

however, it does not prevent the operation’s target tissues from registering noxious stimuli.¹⁶ When the surgeon cuts into the patient’s abdomen, the tissues still send messages to the brain (unless nerves also have been locally blocked)—principally to the thalamus,¹⁷ insula,¹⁸ and somatosensory cortex¹⁹—relaying information. This signal transmission, called “nociception,” meaning the detection and transmission of signals about noxious stimuli, happens even though the patient does

not feel the incision.²⁰ Nociception does not translate into pain, though, because the brain is not at that moment conscious, and thus the person remains unaware.²¹

At first, this distinction between pain and nociception might seem peculiar. The distinction becomes intuitive and familiar, however, if we shift from thinking about pain to other phenomenological states like cold, thirst, or hunger. If a patient is anaesthetized for long enough, blood-sugar levels may drop or the patient may become dehydrated; however, the patient will not feel hungry or thirsty. Operating theaters are kept cool, causing the patient’s body temperature to drop; even so, the patient will not feel cold (at least until the patient wakes up). We would not expect the unconscious patient to feel these things; all phenomenological (or experiential) states require consciousness.²² Pain perception is continuous with all other subjectively perceived body states, which can only be said to exist when they intrude upon consciousness.²³

Accordingly, the nociception/pain distinction does not differ much from the relationships between lack of sleep and fatigue, dehydration and thirst, and so forth. This fundamentally subjective, phenomenological quality of pain has generated extensive literature (and controversy) within the field of philosophy of mind.²⁴ Certainly, different people may have different experiences of pain, even in response to the same external or internal stimuli. Yet, understanding pain—or hunger or cold or thirst—for most practical purposes ought not be particularly mysterious or require unraveling the nature of consciousness.

B. ACUTE PAIN IN THE SCANNER

The brain’s processing of different noxious stimuli correlates with activation in several specific regions. Further, the degree of activation in certain parts of the brain correlates well with the intensity of pain or discomfort reported by a subject. In other words, the physiology and the phenomenology seem closely related. The main challenge is that the degree of activation and its relationship to the intensity of pain or discomfort does not correlate very well across subjects. This section describes the brain regions involved in pain processes and the fMRI research correlating brain activation with subjective experience.

1. Specific Areas of Brain Activity Correlate with Painful Stimulus

Many regions of the brain become active in research subjects who experience a painful heat stimulus.²⁵ Identified in the 1990s with PET scanning,²⁶ the major areas that display activity in response to acute pain include the anterior insula, anterior cingulate cortex (ACC), primary and secondary somatosensory cortex, and thalamus.²⁷ More recent acute-pain studies also find activation in the prefrontal cortex, supple-

16. See Robert J. Gatchel et al., *The Biopsychosocial Approach to Chronic Pain: Scientific Advances and Future Directions*, 133 *PSYCHOL. BULL.* 581, 582 (2007).

17. The thalamus is “the main relay site for nociceptive inputs before cortical and subcortical structures.” Petra Schweinhardt et al., *Imaging Pain in Patients: Is It Meaningful?* 19 *CURRENT OPINION NEUROLOGY* 392, 397 (2006).

18. See M.N. Baliki et al., *Parsing Pain Perception Between Nociceptive Representation and Magnitude Estimation*, 101 *J. NEUROPHYSIOLOGY* 875, 885 (2009) (describing how the insula activates sensory modalities during pain perception).

19. NATIONAL LIBRARY OF MEDICINE, *Somatosensory Cortex*, in *MEDICAL SUBJECT HEADINGS*, available at http://www.nlm.nih.gov/cgi/mesh/2014/MB_cgi?mode=&index=12446&field=all&HM=&II=&PA=&form=&input= (defining the somatosensory cortex as the “[a]rea of the parietal lobe concerned with receiving general sensations”).

20. Gatchel et al., *supra* note 16, at 582.

21. *See id.*

22. Similarly, though many of us have had the experience of being woken from sleep by pain, we did not feel it as pain until we awoke.

23. *See id.*; cf. Donald D. Price et al., *Integrating Experiential-Phenomenological Methods and Neuroscience to Study Neural Mechanisms of Pain and Consciousness*, 11 *CONSCIOUSNESS & COGNITION* 593, 597 (2002) (arguing that a subjective, “first person experiential” approach is an essential component to the study of pain).

24. *See, e.g.,* Murat Aydede & Güven Güzeldere, *Some Foundational Problems in the Scientific Study of Pain*, 69 *PHIL. SCI.* S265, S266

(2002); Price et al., *supra* note 23, at 595; Jennifer Radden, *A Confusion of Pains: The Sensory and Affective Components of Pain, Suffering, and Hurt*, in *FACT AND VALUE IN EMOTION* 65, 66–69 (Louis C. Charland & Peter Zachar eds., 2008); Sydney Shoemaker, *The First-Person Perspective*, in *THE NATURE OF CONSCIOUSNESS: PHILOSOPHICAL DEBATES* 503, 503–05 (Ned Block et al. eds., 1997).

25. A heat stimulus—a heated piece of metal applied to the arm—is the most common research protocol for acute pain in the lab. A standardized heat stimulus delivered by laser is also commonly used. Use of uniform stimuli allows researchers working in different laboratories to compare their results. *See, e.g.,* Susanna J. Bantick et al., *Imaging How Attention Modulates Pain in Humans Using Functional MRI*, 125 *BRAIN* 310, 312 (2002) (applying “[t]hermal noxious stimuli . . . using a thermal resistor” in measuring “experimentally induced pain”).

26. PET stands for “positron emission tomography.” For an overview of different brain imaging techniques, see generally MATT CARTER & JENNIFER SHIEH, *GUIDE TO RESEARCH TECHNIQUES IN NEUROSCIENCE* 1–23 (2010).

27. *See* Kenneth L. Casey et al., *Positron Emission Tomographic Analysis of Cerebral Structures Activated Specifically by Repetitive Noxious Heat Stimuli*, 71 *J. NEUROPHYSIOLOGY* 802, 805–06 (1994); A. May, *Neuroimaging: Visualising the Brain in Pain*, 28 *NEUROLOGICAL SCI.* S101, S101 (2007) (summarizing earlier PET research). Typically, activation is seen in the contralateral thalamus. U. Bingel et al., *Single Trial fMRI Reveals Significant Contralateral Bias in Responses to Laser Pain Within Thalamus and Somatosensory Cortices*, 18 *NEUROIMAGE* 740, 740–41 (2003).

mental motor cortex, basal ganglia, cerebellum, amygdala, hippocampus, hypothalamus, and periaqueductal gray (PAG).²⁸ This section will briefly describe the role of these various brain regions and why pain response is distributed so widely across the brain.

So many parts of the brain respond to painful stimuli because pain is a multidimensional experience: it involves sensory, motor, and affective components as well as memory and executive functions (like planning and self-control).²⁹ When a conscious person perceives pain, activity likely arises in the prefrontal cortex, thalamus, insula, anterior cingulate cortex, and brain areas correlated with sensory perception (somatosensory cortex and somatosensory association areas). The individual may reflexively or deliberately move away from the stimulus, activating brain areas involved in motor function (like the motor cortex and cerebellum).³⁰ The individual may turn to distractions in order to minimize the experience of the pain, an exercise in self-control that also would engage the prefrontal cortex.³¹ The individual will have an instantaneous, negative affective reaction to the pain, engaging the amygdala and anterior cingulate cortex, key areas of the brain involved with emotional processing.³² The individual may utilize implicit and explicit memory to identify what the pain experience is; this would involve several areas of the brain, including the hippocampus and likely also (again) the somatosensory association cortex. If the memory involves visual recollection, there will also be activity in, among other areas, the occipital lobe. Thus, the sum of processes and reactions that we call “pain” involves nearly a whole-brain experience.

2. Degree of Brain Activation Correlates with Degree of Reported Pain

Studies involving fMRI acute-pain imaging show that a person’s degree of brain activation correlates—not perfectly, but well—with self-reported degree of pain. That is, people who report more sensitivity to a painful stimulus show greater brain activity in areas of the brain associated with pain perception (and people who report less sensitivity to the stimulus show less). Therefore, brain activation at least crudely matches subjective experience.

This is a truly striking result because it suggests an answer to the centuries-long debate about whether people who respond more or less “stoically” to pain actually experience the pain differently or whether the more stoic one is simply mentally tougher in the face of the same degree of experienced pain. In laboratory subjects who report their degree of pain honestly (*i.e.*, they have incentives neither to exaggerate nor act tough), a direct relationship exists between biological response and psychological experience. This means that people who report pain differently actually experience pain differently.

3. Experimental Error

The kinds of fMRI-based pain assessments described above could produce both type-one and type-two errors—that is, false positives and false negatives. False-positive and false-negative results from fMRI pain detection could result in several ways.

First, consider the case in which activation above a significant threshold is present in areas of the brain associated with pain perception (both nociception and affective experience). This should indicate that a person is experiencing pain. However, a person may not subjectively feel pain. Predicting pain based on this scan pattern could produce type-one errors.

The second case is where activation above a significant threshold is not present in areas of the brain associated with pain perception (nociception and affective experience). This should indicate that a person is not experiencing pain. However, the subject still could subjectively be experiencing pain because of a low pain threshold (whether as a result of transient affective state or physiology or some combination of both). Predicting the absence of pain based on this scan pattern could produce both type-one and type-two errors.

The third case is where areas of the brain associated with nociception experience activation above a significant threshold but areas related to affective experience do not. This could produce either a type-one or type-two error. It could suggest any of the following: that the subject is registering nociception but not experiencing pain; the subject is registering nociception and is experiencing pain but is not highly affectively aroused; the subject is sedated, experiencing interference with affective processing of the painful stimulus; or that the areas of the brain related to affective experience are otherwise suppressed (whether through chemical means, unconsciousness, organic brain damage, or difference). On the phenomenological level, it would not be possible to determine from the scan whether the subject definitely does or does not experience pain.

The fourth case is the flipside: where activation above a significant threshold is present in areas of the brain associated with affective experience but not in the areas related to nociception. This also could produce either a type-one or type-two error. It could suggest any of the following: that the subject is not in pain; the subject is not registering significant nociception but is experiencing pain because of unusual sensitivity to pain; the subject is not registering significant nociception but is experi-

“Studies involving fMRI acute-pain imaging show that a person’s degree of brain activation correlates—not perfectly, but well—with self-reported degree of pain.”

28. See Gatchel et al., *supra* note 16, at 592–93 (citing and reviewing extensive literature).

29. See *id.* at 582.

30. See Jeanne D. Talbot et al., *Multiple Representations of Pain in Human Cerebral Cortex*, 251 *SCIENCE* 1355, 1355–56 (1991). But see Andrew K. Jones et al., *Localization of Responses to Pain in*

Human Cerebral Cortex, 255 *SCIENCE* 215, 215 (1992) (presenting Jones’s comment on Talbot’s article and Talbot’s response).

31. See Bantick et al., *supra* note 25, at 316–18.

32. See *id.* at 317 (noting how the anterior cingulate cortex provides an emotion-processing function).

“[T]he brain does not have any single ‘pain spot’ or pain-perceiving organ[, and] pain varies across and within subjects and depends on internal and external context.”

encing pain because the subject is highly affectively aroused (e.g., by fear). Thus, it would not be possible to determine with confidence from the scan whether the subject definitely is or is not experiencing pain.

In each of the above examples, the “threshold” for activation is itself absolutely critical in determining whether the subject is likely experiencing pain or not. A true resting state for the brain does not exist, as the only time when the brain

performs no activity at all is at death. Thus, researchers have to determine what degree of activity in a particular brain region counts as “significant,” a trickier and more subjective task than determining statistical significance for, say, population size in an epidemiological study or political poll. Researchers determine significance in fMRI studies by balancing signal and noise. If the software that crunches the data from the scans is programmed to be very sensitive to differences in scan signal between task one and task two, it will pick up even very faint, relative activations.³³ This may help researchers focus in on a needle in a haystack, but it will also make it look like there are needles everywhere. However, if the software is programmed to be less sensitive to differences in signal between task one and task two, then it will only pick up differences that are comparatively large; in a sense, it will find the broomstick in the haystack but might miss some needles.

C. DIRECT LEGAL UTILITY?

As summarized above, the brain does not have any single “pain spot” or pain-perceiving organ. And we know that pain varies across and within subjects and depends on internal and external context. Yet, a few affirmative generalizations can be made. First, nociception of various kinds generally will involve activation in the insula and thalamus,³⁴ although many other phenomena also involve activation of these brain regions. Second, fMRI may be useful for inferring the absence of nociception and pain. Third, fMRI may have some limited utility in supporting inferences about the presence and degree of acute pain. These proposed techniques or methods may generate type-one and type-two errors; researchers would need to do more work to establish the confidence levels in the results. Additionally, such tools may be subject to countermeasures.

1. Inferring Absence of Nociception and Pain

At this point in its development, fMRI could be used to indi-

cate the absence of nociception and acute pain. In the presence of nociception, observers can expect, at a minimum, engagement of the contralateral thalamus, insula, and somatosensory cortex. This should be true across individuals and types of noxious stimuli. Additionally, in the presence of subjectively perceived acute pain, activation would typically occur in areas related to affective processing, including the anterior cingulate cortex and amygdala. There would also be heightened activation in the prefrontal cortex as a marker of executive function.

Note that the inference of no pain follows only in the complete absence of such activation, not if merely very low coordinated activation is present. Because pain is phenomenological, the only sure way to know if a person is in pain is to ask. A person showing very low levels of activation in these target regions may still genuinely be in pain.

2. Partially Inferring Presence and Degree of Acute Pain

Inferring the presence and degree of acute pain with fMRI poses a greater challenge than demonstrating its absence. As noted above, the degree of activation correlates fairly well with degree of experienced pain. Thus, a research subject must honestly self-report experienced pain for a researcher to accurately correlate the pain to a contemporaneous scan. If a person either cannot respond (maybe he or she is in a coma or has locked-in syndrome) or has an incentive not to respond honestly, the researcher has no reliable way to infer the true pain level from the scan in the absence of a reliable self-report. Again, this result stems from the fact that people experience stimuli as “painful” at quite different thresholds and reflect the experience in different levels of brain activation.

In the best-case scenario, a researcher would take readings of an individual subject’s self-reported pain levels and brain activation over time in response to stimuli graduated from non-noxious to highly noxious. This would establish this subject’s average sensitivity to noxious stimuli. Then, the researcher could expose the subject to a stimulus, take a brain image, and estimate the subject’s phenomenological experience of pain based on a comparison with prior correlations of self-reporting and scan data. The researcher could then assign a confidence level to the phenomenological guess.

Even in this purely hypothetical best-case scenario, prediction of pain phenomenology remains dicey because individual subjects simply are not very consistent in their pain perception over time and across different internal contexts.³⁵ In testing across subjects, it might be possible to say that a particular response would fall a certain number of standard deviations away from the average subject response. The researcher could then give a probabilistic or statistical estimate of how likely the subject will experience the degree of pain reported. These

33. See ARTHUR W. TOGA & JOHN C. MAZZIOTTA, *BRAIN MAPPING: THE METHODS* 341 (2d ed. 2002) (discussing signal-to-noise ratios in fMRI scanners).

34. See *supra* notes 17–18 and accompanying text.

35. Researchers refer to this as the effect of “set and setting.” “Set” is the subject’s ingoing mindset (fearful, eager, relaxed) while “setting” is the context in which the experience takes place, including

the subject’s perceived degree of control. The same subject may receive the same amount of the same compound and have an intensely different reaction based on changes in set and setting across the two experiences. See Louis A. Faillace & Stephen Szara, *Hallucinogenic Drugs: Influence of Mental Set and Setting*, 29 *DIS-EASES NERVOUS SYS.* 124, 125–26 (1968).

numerous extrapolative steps, though, reduce the power and credibility of such tests.³⁶

II. CASE STUDY: PAIN AS HEURISTIC IN TORTURE AND TORTURE-MURDER

Part I explored the question of whether neuroimaging technologies can measure acute pain with precision and reliability on an individual level and concluded that fMRI acute-pain measurement has significant technical and in-principle limitations, as well as some power under carefully controlled experimental conditions. This part turns to the doctrinal and epistemic questions of whether, if perfect pain quantification were to exist, it would improve doctrine and practice in certain putatively pain-defined areas of law. It explores these questions through the first of two sets of case studies:³⁷ the cases of criminal torture-murder and state torture.

A. TORTURE-MURDER

The importance of pain as a signal in the law seems nowhere clearer than in the historically, deeply rooted crime of torture-murder. Torture-murder consists of a simple act requirement and a single intent requirement. For the act requirement, torture-murder must include the commission of

acts of torture resulting in death;³⁸ for the intent requirement, there must be something like the “intentional infliction of extreme and prolonged pain with the intent to cause suffering.”³⁹ Though torture-murder statutes appear to limit the offense to the infliction of pain for particular corrupt purposes only, that limitation turns out to be hollow because the statutorily proscribed purposes are often “revenge, extortion, persuasion, [punishment], or . . . any sadistic purpose.”⁴⁰

While defining “torture” relative to state actors remains highly contested,⁴¹ state legislatures and courts appear to have little difficulty defining exactly what torture is among private parties. It is the “intentional infliction of extreme and prolonged pain”⁴² or “grievous pain and suffering”⁴³ upon another. Further, courts have held that because society generally has enough common understanding of this definition of torture, torture-murder statutes provide sufficient notice of prohibited conduct and thus are not unconstitutionally vague.⁴⁴

“The importance of pain as a signal in the law seems nowhere clearer than in the deeply rooted crime of torture-murder.”

36. In presenting this work in informal talks, the suggestion has arisen several times that researchers could use fMRI to compile tables of the “average painfulness” of particular types of torture. This, proponents argue, would at least lead to transparency and enforceability in torture practices.

Three fundamental problems arise from this argument: it is unnecessary, it misses the point, and it invites more subterfuge than it eliminates. First, a sophisticated laboratory inquiry with 7-tesla magnets on a statistically significant set of subjects is not necessary to tell any mentally and morally competent person what kinds of things hurt and about how much. Second, much conduct that is physically painful but not excruciating is understood to constitute torture because of the conjunction of its painfulness and its normative meaning—for example, rape, sodomy, and sexual abuse. Third, as soon as certain conduct becomes *de jure* insufficiently painful to constitute torture, the race to exacerbate the painfulness of the permitted conduct will ignite. This would create a back door into torture—victims could be treated with every appearance of lawfulness, indeed with a presumption of lawfulness, yet suffer torture.

This is not conjecture or speculation. In 2005, the United States Department of Justice issued two interrogation memoranda that used pain-perception research in precisely this way. These recently declassified memoranda used the research of, among others, Bernd Kundermann et al., *The Effect of Sleep Deprivation on Pain*, 9 PAIN RES. & MGMT. 25, 31 (2004), available at <http://www.pulsus.com/journals/toc.jsp?sCurrPg=journal&xjnlKy=7&isukY=550> (concluding that sleep deprivation leads to heightened pain sensitivity and reduced response to analgesic drugs), to recommend extended sleep deprivation—specifically for the purpose of enhancing the painfulness of otherwise-authorized interrogation techniques, including beatings and waterboarding. See *Justice Department Interrogation Memos Abuse Sleep Deprivation Research*, UNION OF CONCERNED SCIENTISTS, http://www.ucusa.org/scientific_integrity/abuses_of_science/justice-department.html (citing Justice Department memoranda to the Central Intelligence Agency, available at <http://documents.nytimes.com/justice-department-memos-on-interrogation-techniques#p=39>); Noah Schactman, *Sleep Scientists:*

Research Twisted to Justify Torture, WIRED.CO.UK, Apr. 22, 2009, <http://www.wired.co.uk/news/archive/2009-04/23/sleep-research-twisted-to-justify-torture>; Michael Scherer, *Scientists Claim CIA Misused Work on Sleep Deprivation*, TIME, Apr. 21, 2009, available at <http://content.time.com/time/nation/article/0,8599,1892897,00.html>.

37. The second set of case studies appears *infra* Part III.

38. See, e.g., CAL. PENAL CODE § 189 (West 2008) (including murder “by means of . . . torture” in the definition of first-degree murder); IDAHO CODE ANN. § 18-4001 (defining murder to include “the intentional application of torture to a human being, which results in the death of a human being”).

39. IDAHO CODE ANN. § 18-4001. In states like Idaho, the intent requirement is relaxed; an offense constitutes torture-murder not only where “intent to cause suffering” is present but also “irrespective of proof of intent to cause suffering.” *Id.* (emphasis added).

40. *People v. Cook*, 139 P.3d 492, 519 (Cal. 2006) (internal quotation marks omitted). This California standard does not include “punishment,” but many other statutes do. See, e.g., IDAHO CODE ANN. § 18-4003(a) (including “intent . . . to execute vengeance” in first-degree torture-murder). Legal dictionaries define “torture” as follows: “[t]he infliction of intense pain to the body or mind to punish, to extract a confession or information, or to obtain sadistic pleasure.” See, e.g., BLACK’S LAW DICTIONARY 1627 (9th ed. 2009).

41. See *infra* notes 66–67 and accompanying text.

42. IDAHO CODE ANN. § 18-4001. This definition of private torture has long been established in American law. See, e.g., *Territory v. Vialpando*, 42 P. 64, 65 (N.M. 1895) (defining torture as the infliction of “pain, anguish, pang[, or] . . . extreme pain”).

43. 40 AM. JUR. 2d Homicide § 41 (2008) (citing *State v. Pierce*, 488 S.E.2d 576, 588 (N.C. 1997)).

44. In *State v. Crawford*, 406 S.E.2d 579, 589 (N.C. 1991), the defendant challenged his conviction under the state’s torture-murder statute on the ground that the statute’s use of the term “torture” was vague. The North Carolina Supreme Court denied the challenge, holding that the meaning of torture as extreme or prolonged pain is more or less self-evident and “puts a reasonable person on notice of what is forbidden.” *Id.* at 590.

“One might suggest that if it were possible to quantify average pain for particular acts committed upon the body, then it might also be possible to calibrate punishment even more precisely”

A conviction on a torture-murder charge does not require intent to cause death. This is remarkable because it places torture-murder with very particular company: except for felony murder, torture-murder is the only capital crime for which the defendant need not have had any intent to kill.⁴⁵ The mere intent to inflict pain satisfies the *mens rea* requirement.⁴⁶

In states that do not have specific torture-murder statutes but that do have the death penalty, pain inflicted equal to

torture—so-called “heinous, atrocious, and cruel” (HAC) conduct upon the victim⁴⁷—can differentiate ordinary murder from capital murder. HAC factors are effectively identical to “torture” as defined under torture-murder statutes; HAC conduct is the infliction of “severe pain, agony, or anguish”⁴⁸ or the “unnecessary and wanton infliction of severe pain.”⁴⁹

Torture-murder and HAC statutes show that the state metes out additional punishment for the infliction of torture upon the victim, defined as “extreme” or “grievous pain.” These would seem, therefore, to be offenses largely defined by a quantum of pain. Published opinions in torture-murder and HAC cases dwell on the suffering of the victim’s last moments and the degree of pain and fear the victim likely felt.⁵⁰ This reinforces the apparent linkage between the extra punishment that the state inflicts on the torture- or HAC-murderer and the victim’s suffering.

One might suggest that if it were possible to quantify average pain for particular acts committed upon the body, then it might also be possible to calibrate punishment even more precisely.⁵¹ Alternatively, one might imagine a defense to a torture-murder or HAC charge that the defendant’s conduct upon the victim was not sufficiently painful to meet the standards required by these statutes.⁵²

And yet, a definition of an offense or a defense based on quantum of pain⁵³ might seem intuitively wrong even if it were empirically feasible. To illustrate this point, we might hypothesize an unconscious or insensate victim. A torture-murderer, whose sole intent is to cause pain, physically abuses the unconscious victim. The victim perceives nothing and then dies from the injuries. The offender will in all cases be liable for some category of homicide. One who subscribes to the hedonic or experiential understanding of pain-based offenses likely would argue that, because the victim did not perceive any torture, the offender does not merit any additional punishment; in hedonic terms, the torture component of such an offense is a nullity. Abuse of the unconscious victim, on the hedonic view, could equate to abuse of a dead body, a far lesser offense that obviously has no hedonic component and does not avenge hedonic wrongs.⁵⁴

The extra punishment for torture-murder of an unconscious victim (beyond the punishment for non-torture murder) shows that a concern for hedonic harms to victims does not drive the torture-murder/HAC cases. While torture-murder and HAC are indeed defined in hedonic terms, convictions for these offenses (and their affirmances) are independent of the victim’s perception. As clearly articulated by the California Supreme Court: “[A] defendant may be found guilty of murder by torture even if the victim is never aware of any pain.”⁵⁵

Numerous jurisdictions have held that a conviction for tor-

45. See, e.g., *People v. Steger*, 546 P.2d 665, 669 (Cal. 1976) (en banc).

46. Murder by torture does not require premeditation or intent to kill. Cf. *People v. Davis*, 234 Cal. Rptr. 859, 863 (Ct. App. 1987) (inferring that the jury found “willful, deliberate and premeditated killing” in the absence of a finding of torture-murder). Specific intent to kill is irrelevant when first-degree murder is perpetrated by torture. See *Crawford*, 406 S.E.2d at 587. Neither premeditation nor intent to kill is an element of first-degree murder perpetrated by torture. See *State v. Phillips*, 399 S.E.2d 293, 303 (N.C. 1991).

47. Less frequently, states use the formulation “heinous, cruel, and depraved” (HCD). See generally Richard W. Garnett, Note, *Depravity Thrice Removed: Using the “Heinous, Cruel, or Depraved” Factor to Aggravate Convictions of Nontriggermen Accomplices in Capital Cases*, 103 YALE L.J. 2471, 2497–99 (1994) (describing HCD factors and detailing the relationship between statutory cruelty and physical pain).

48. *State v. Piper*, 709 N.W.2d 783, 799 (S.D. 2006) (quoting *State v. Rhines*, 548 N.W.2d 415, 448 (S.D. 1996) (defining torture under S.D. CODIFIED LAWS § 23A-27A-1(6) (2004), as the “unnecessary and wanton infliction of severe pain, agony, or anguish” and “the intent to inflict such pain, agony or anguish”); see also *State v. Kiles*, 857 P.2d 1212, 1221 (Ariz. 1993) (en banc) (“[C]ruelty may be found when a defendant intends to inflict mental anguish or physical pain.”). Some courts require a finding of specific intent to inflict pain and suffering. See, e.g., *Bonifay v. State*, 626 So. 2d 1310, 1313 (Fla. 1993) (defining HCD factors and stating that

they are applicable only where a defendant intends extreme pain and torture); *Commonwealth v. Daniels*, 612 A.2d 395, 400 (Pa. 1992) (per curiam) (noting that the aggravating circumstance of torture requires intent to inflict pain).

49. *Piper*, 709 N.W.2d at 799. Here, “[u]nnecessary pain’ implies suffering in excess of what is required to accomplish the murder.” *Id.* (quoting *Rhines*, 548 N.W.2d at 452) (internal quotation marks omitted).

50. See, e.g., *People v. Campbell*, 239 Cal. Rptr. 214, 224 (Ct. App. 1987) (noting in a torture-murder case that the defendant left the victim “to suffer in pain”); *Evans v. State*, 800 So. 2d 182, 194 (Fla. 2001) (noting in a HAC case that the victim “suffered fear and emotional strain”).

51. See discussion *supra* Part I.C.2.

52. Cf. *People v. Cole*, 95 P.3d 811, 845 (Cal. 2004) (articulating a rule that the victim need not perceive the pain for a conviction for murder by torture to be upheld); *People v. Pensinger*, 805 P.2d 899, 910 (Cal. 1991) (en banc) (articulating a similar rule).

53. Imagine, for example, a crime that required the victim to experience one hundred units of pain. If the victim only suffered seventy-three units of provable pain before death, the defendant would enjoy immunity from conviction for the crime.

54. See, e.g., FLA. STAT. ANN. § 872.06 (West 2000) (defining abuse of a dead human body as a second-degree felony).

55. *People v. Elliot*, 122 P.3d 968, 978 (Cal. 2005) (emphasis added) (citations omitted).

ture-murder may lie where the victim has no awareness of the torture inflicted.⁵⁶ This upends the notion that what we punish in this category is the actual suffering inflicted on the victim. Yet how can actual pain be irrelevant to torture-murder, an offense statutorily defined by the infliction of “extreme” or “grievous pain” or “agony”?⁵⁷ This article posits that, in this context, “infliction of pain” is not a description of facts about the body but rather a proxy for certain values. Punishment aims at the corrupt tastes and preferences of the torture-murderer or HAC murderer, not the pain purportedly caused to the victim. A review of the reported cases supports this interpretation; in the last 25 years (1985 to present), opinions have been issued in more than 200 torture-murder cases.⁵⁸ Of those, more than half involved some kind of battery on the sexual organs of the victim.⁵⁹ Nearly half involved acts committed against children or in the presence of children.⁶⁰

Because the degree of pain experienced by the victim is largely or totally irrelevant, torture-murder doctrine and caselaw illustrate how a legal regime that appears to turn on pain experience and that is statutorily defined in terms of physical pain actually rests on the notion of pain-as-proxy-for-values. The case

of torture-murder helps show that adoption of a hedonic theory of criminal punishment would be inapposite because felt pain is not the necessary (or perhaps even the primary) object of these legal prohibitions.

B. STATE TORTURE AND PAIN MEASUREMENT

The common understanding of state-sanctioned or official torture finds close ties to pain. After reflecting upon the definition of “torture,” most people would suggest that torture equates to severe physical pain, inflicted on the victim intentionally (and not beneficially). Indeed, this sense that torture involves severe pain or the threat of severe pain to the victim or the victim’s loved ones⁶¹ is tracked by definitions drawn from dictionaries,⁶² encyclopedias,⁶³ blogs, and other repositories of cultural meaning⁶⁴ and has remained largely consistent over time.⁶⁵

“This article posits. . . ‘infliction of pain’ is not a description of facts about the body but rather a proxy for certain values.”

56. See, e.g., *id.* (establishing the “no awareness” rule in California); *Hill v. State*, 724 P.2d 734, 736 & n.4 (Nev. 1986) (implying a similar rule in Nevada by upholding the defendant’s conviction while noting that the victim was paralyzed); *Commonwealth v. Brown*, 711 A.2d 444, 448, 454 (Pa. 1998) (implying a similar rule in Pennsylvania). As discussed in Part I.A.2, an unconscious person cannot have subjective awareness of pain, as pain has no existence distinct from the awareness thereof.

57. See *supra* notes 42–43 and accompanying text.

58. An informal search of “all state and all feds (pub & unpub)” databases on Westlaw, with a date parameter starting (arbitrarily) with 1985, using the search phrase “tortur! /50 (homicide murder manslaughter) &da(aft 1/01/1985)” pulled several thousand cases from which relevant results were counted.

59. See, e.g., *Hernandez v. State*, 50 P.3d 1100, 1104–05 (Nev. 2002) (death of adult woman in rape and sexual battery with knife); *Commonwealth v. Elliott*, 700 A.2d 1243, 1247 (Pa. 1997) (death of adult woman during rape and sexual battery, involving strangulation).

60. See, e.g., *People v. Mincey*, 827 P.2d 388, 398–99 (Cal. 1992) (murder by prolonged beating of five-year-old boy); *State v. Lee*, 501 S.E.2d 334, 337–39 (N.C. 1998) (abuse of child over a one-week period resulting in death); *Hernandez*, 50 P.3d at 1104–05; *Brown*, 711 A.2d at 454 (death of a child by sexual torture where victim was possibly unconscious due to blood loss); *Commonwealth v. Edmiston*, 634 A.2d 1078, 1084 (Pa. 1993) (mutilation of a two-year-old kidnapping victim by beating, carving, and sexual abuse).

61. We might conceive of “mental suffering” and severe physical pain as equally constitutive of torture. The relationship of physical and mental pain, and whether mental “suffering” and mental “pain” are equivalent or identical concepts and experiences, deserve exploration in their own right but are beyond the scope of this article. Preliminary work suggests that many forms of acute emotional distress involve the same brain regions as acute-physical-pain experience—that the neurobiology tracks the phenomenology when we speak of “the pain of rejection” or the feeling of “broken-heartedness.” In this domain, language is wise; it contains intuitions of our embodiment. It is not my normative claim

that mental pain cannot constitute torture. Rather, this is a descriptive claim that, while torture definitions include a mental suffering or anguish prong, the suffering inherent to torture remains constructed as primarily physical.

62. 18 OXFORD ENGLISH DICTIONARY 278 (James A.H. Murray et al. eds., 2d ed. 1991) (defining torture as the “infliction of severe bodily pain, as punishment or a means of persuasion; spec. judicial torture, inflicted by a judicial or quasi-judicial authority, for the purpose of forcing an accused or suspected person to confess, or an unwilling witness to give evidence or information”).

63. See, e.g., Nigel S. Rodley, 11 ENCYCLOPEDIA BRITANNICA 861 (15th ed. 1998), available at <http://www.britannica.com/EBchecked/topic/600270/torture> (defining “torture” as “the infliction of severe physical or mental pain or suffering for a purpose, such as extracting information, coercing a confession, or inflicting punishment . . . [that is] normally committed by a public official or other person exercising comparable power and authority”); Seumas Miller, *Torture*, STAN. ENCYCLOPEDIA PHIL. (Apr. 29, 2011), <http://plato.stanford.edu/entries/torture/> (“Torture includes such practices as searing with hot irons, burning at the stake, electric shock treatment to the genitals . . . and denying food, water or sleep for days or weeks on end. All of these practices presuppose that the torturer has control over the victim’s body, e.g. the victim is strapped to a chair. Most of these practices, but not all of them, involve the infliction of extreme physical pain.”).

64. See, e.g., *The Ethics of Torture*, PHILOSOPHY TALK (Apr. 10, 2010), <http://philosophytalk.org/shows/ethics-torture-1> (pointing out the broader categorization of torture to include both physical and mental anguish); cf. David Luban, *The Fundamental Trick: Pretending That “Torture” is a Technical Term*, BALKINIZATION (Feb. 26, 2010), <http://balkin.blogspot.com/2010/02/fundamental-trick-pretending-that.html> (arguing that torture is defined by severe pain, as elaborated in David Luban, *Liberalism, Torture, and the Ticking Time Bomb*, 91 VA. L. REV. 1425, 1425–28 (2005) [hereinafter Luban, *Liberalism*]).

65. Elizabeth Hanson, *Torture and Truth in Renaissance England*, 34 REPRESENTATIONS 53, 57 (1991) (quoting Sir Thomas Smith to have defined torture as “torment . . . which is used by the order of the civill lawe and custome . . . to put a malefactor to excessive paine,

“The essential relationship between torture and pain is confirmed by sources of political meaning such as definitions of torture promulgated by major supranational organizations.”

What constitutes “severe pain”? This single question seems to have become the battleground for current debates about what constitutes torture and separates it from so-called “harsh interrogation tactics.” Quantum of pain provides the arena in which opponents fight out the questions of what constitutes torture, what constitutes the lesser but still prohibited “cruel, inhuman, and degrading” (CID) treatment,⁶⁶ and what constitutes permissible conduct.⁶⁷ In this way, “the threshold test of suffering has been used in an attempt to fly below the radar of the absolute prohibition on torture”⁶⁸ as well as to challenge practices not currently classified as torture.

Could pain quantification for interrogation tactics even be possible? In foreign prisons where torture is practiced and in the sites of extraordinary rendition to which the United States has sent high-value suspects for interrogation (“black sites”), the experiment is already underway. If interrogators or jailers already perform these functions, it should be possible to collect data on the average pain associated with each technique. There could be robust debate on what pain threshold should separate torture from CID treatment and CID from harsh practices, as well as data integrity. But there is no reason *a priori* why these theoretical and empirical problems could not also be resolved if torture could be reduced to pain experience.

Like torture-murder, however, torture points toward the normative dimensions of physical experience. It shows that, while we cannot separate ourselves from our physicality, we are not entirely reducible to it because we process our relationships with our bodies through normative constructs. Further, discourse about pain within the context of torture may hide the ball; for example, when the ostensible issue refers to severity of pain, the actual issue may be the values at stake in the treatment of detained persons. In relying on a discourse concerned with the apparently physical, we may actually suppress more contentious questions about values. In this way, pain serves as a heuristic for values and not as a description of physical facts at all.

In any case, no measurement system for pain quantification alone could ever definitively answer what torture is or is not and whether in any given context particular pain-causing actions ought to be permissible. Stances toward torture correlate with relative emphases on pain; that is, the harsher the conduct the proponent seeks to permit, the more closely the definition hews to a pain formula (and vice versa). Further, certain of the harms that flow from torture are independent of the harms to torture victims but rather cause harm to the state itself and to its relations with other states, again pointing to the irreducibility of torture as solely affecting the victims’ physical experience. This relationship between the harms of torture and the nature of the state is tied to the fundamental rejection of torture in classical liberal political theory.

1. Torture as Severe Pain

The essential relationship between torture and pain is confirmed by sources of political meaning such as definitions of torture promulgated by major supranational organizations. The United Nations Convention Against Torture and Other Cruel, Inhuman or Degrading Treatment or Punishment (UN Convention Against Torture) defines torture as

[A]ny act by which severe pain or suffering, whether physical or mental, is intentionally inflicted on a person for such purposes as obtaining from him or a third person information or a confession, punishing him for an act he or a third person has committed or is suspected of having committed, or intimidating or coercing him or a third person.⁶⁹

This definition hinges on the infliction of severe physical pain or mental anguish. Severe pain does not suffice in itself, however; the definition also requires state action and the restriction to particular purposes. But the essential term of this definition is physical or mental pain; without it, conduct might be coercive but would not amount to torture.

Unlike the UN Convention Against Torture, the European Convention on Human Rights, though it bars torture, does not delineate what constitutes it.⁷⁰ Jurisprudence under the Convention, however, has relied upon a “severity of suffering” test.⁷¹

United States law defines torture compatibly with the UN Convention Against Torture. Section 2340 of Title 18 of the U.S. Code provides that torture is “an act committed by a person acting under the color of law specifically intended to inflict

to make him confesse him selfe, or of his fellowes or complices” and noting its absence in English law in the sixteenth and seventeenth centuries (internal quotation marks omitted)).

66. See, e.g., Yutaka Arai-Yokoi, *Grading Scale of Degradation: Identifying the Threshold of Degrading Treatment or Punishment Under Article 3*, 21 NETH. Q. HUM. RTS. 385, 415 (2003).

67. See, e.g., Ian Brownlie, *Interrogation in Depth: The Compton and Parker Reports*, 35 MOD. L. REV. 501, 501–02 (1972) (describing tactics classified in British colonies as permissible “interrogation in depth,” not torture). For a more recent example, consider the extensive public and academic debates over whether waterboarding constitutes torture; cruel, inhuman, and degrading conduct; or permissible enhanced interrogation.

68. Oren Gross, *Are Torture Warrants Warranted? Pragmatic Absolutism and Official Disobedience*, 88 MINN. L. REV. 1481, 1488 (2004).

69. United Nations Convention Against Torture and Other Cruel, Inhuman or Degrading Treatment or Punishment art. 1, Dec. 10, 1984, 1465 U.N.T.S. 113–14 (emphasis added).

70. See European Convention on Human Rights, Convention for the Protection of Human Rights and Fundamental Freedoms art. 3, Nov. 4, 1950, 213 U.N.T.S. 221, 224 (“No one shall be subjected to torture or to inhuman or degrading treatment or punishment.”).

71. Gross, *supra* note 68, at 1488 (citing Fionnuala Ní Aoláin, *The European Convention on Human Rights and Its Prohibition on Torture*, in TORTURE 213, 213–28 (Sanford Levinson ed., 2004)).

severe physical or mental pain or suffering (other than pain or suffering incidental to lawful sanctions) upon another person within his custody or physical control.”⁷²

Definitions from other conventions and those promulgated by nongovernmental organizations emphasize pain in varying degrees; like those in U.S. law, these definitions emphasize the intentionality of the infliction of physical pain and the specific purposes that cause the infliction of pain or suffering to constitute torture. Because of the intimate connection between torture and pain, and perhaps for other important reasons that will be discussed below, “[m]uch recent discussion of torture focuses on the severity of suffering involved.”⁷³

The most notorious recent example of torture defined exclusively in terms of infliction of severe pain is the much debated “Bybee Memo.” This August 2002 memorandum from Assistant Attorney General Jay S. Bybee to then-White House Counsel Alberto Gonzales expressly defines torture by the quantum of pain the victim experiences. The Memo states that to constitute torture under U.S. law,⁷⁴ “severe pain” must be inflicted on a prisoner; further, “severe pain” means pain “akin to that which accompanies serious physical injury such as death or organ failure.”⁷⁵

Although the Bybee Memo and its progeny equate torture and pain, they do so nonsensically: What is the degree of pain equivalent to organ failure or death? Death can be painless; organ failure, too, may be pain-free, as when heart failure causes a person to slip away during sleep. Conversely, excruciatingly painful torments may not result in organ failure. The Bybee Memo adopted this incoherent definition from other U.S. statutes that do not themselves define pain.⁷⁶ It has been criticized extensively for nearly every other aspect of its logic and legitimacy.⁷⁷ Indeed, not long after it became public, the Department of Justice replaced it with new guidance known as the “Levin Memo” that expressly condemned torture.⁷⁸

Yet the heart of the Bybee Memo has not been repudiated or abandoned. The notion remains that torture is best defined by the victim’s quantum of acute pain. The Levin Memo uses as

examples of torture only those practices that inflict the most extreme pain and which would have qualified under the definition of torture found in the Bybee Memo.⁷⁹

“[Some] scholars seek to define torture in terms of power rather than pain.”

2. Torture as Power Relations

While many efforts to define torture described above turn on degree of pain, there is nothing close to a consensus on which acts (or omissions) constitute torture. Taking a different approach, other scholars seek to define torture in terms of power rather than pain. John T. Parry, for example, has advanced the notion that torture is the infliction of even brief, non-severe pain if it occurs “against a background of total control and potential escalation that asserts the state’s dominance and unsettles or destroys the victim’s normative world.”⁸⁰ Similarly, David Sussman has described the true horror of torture as that which results from the “asymmetry of power, knowledge, and prerogative” between interrogator and subject, where “the victim is in a position of complete vulnerability and exposure, the torturer in one of perfect control and inscrutability.”⁸¹ These definitions capture something about the horror of torture that the purely pain-based definitions do not: that the normative dimensions of torture—the ability to psychologically destroy the victim and cause the renunciation of whatever had been held most sacred—comprise an essential component of torture.

At least one important supranational organization has adopted an approach to defining torture that is consistent with the intuitions about torture expressed in these non-pain-based definitions. The Inter-American Convention to Prevent and Punish Torture (Inter-American Convention) looks to the relational aspects of a torture situation rather than to degrees of pain.⁸² The Inter-American Convention defines torture such that any degree of pain may constitute torture provided

72. 18 U.S.C. § 2340(1) (2006) (emphasis added).

73. David Sussman, *Defining Torture*, 37 CASE W. RES. J. INT’L L. 225, 226 (2006).

74. 18 U.S.C. § 2340.

75. Memorandum from Jay S. Bybee, Assistant Attorney Gen., U.S. Dep’t of Justice, to Alberto R. Gonzales, Counsel to the President on Standards of Conduct for Interrogation Under 18 U.S.C. §§ 2340-2340A (Aug. 1, 2002), reprinted in MARK DANNER, TORTURE AND TRUTH: AMERICA, ABU GHRAIB, AND THE WAR ON TERROR 115, 155 (2004).

76. See, e.g., 8 U.S.C. § 1369(d) (2006) (noting that emergency medical conditions include those manifesting symptoms of severe pain); see also 42 U.S.C. § 1395w-22(d)(3)(B) (2006) (same); *id.* § 1395x(v)(1)(K)(ii) (same); *id.* § 1395dd(e)(1)(A) (same); *id.* § 1396b(v)(3) (same); *id.* § 1396u-2(b)(2)(C) (same).

77. Indeed, there is “a near consensus that the legal analysis in the Bybee Memo [is] bizarre.” Luban, *Liberalism*, *supra* note 64, at 1455.

78. Memorandum from Daniel Levin, Acting Assistant Attorney Gen., U.S. Dep’t of Justice, to James B. Comey, Deputy Attorney Gen. (Dec. 30, 2004). The Memo opens by stating: “Torture is abhorrent both to American law and values and to international norms.”

Id. at 1.

79. *Id.* The Levin Memo’s examples of practices that would cause proscribed degrees of severe pain included, for example, “severe beatings to the genitals, head, and other parts of the body with metal pipes . . . ; removal of teeth with pliers; . . . cutting off . . . fingers[.]” and other, similar conduct. *Id.* at 10 (citing Mehinovic v. Vuckovic, 198 F. Supp. 2d 1322, 1332–40, 1345–46 (N.D. Ga. 2002) and Daliberti v. Republic of Iraq, 146 F. Supp. 2d 19, 22–23 (D.D.C. 2001)); see also Luban, *Liberalism*, *supra* note 64, at 1456 (“Although the Levin Memo condemns torture and repudiates the Bybee Memo’s narrow definition of ‘severe pain,’ a careful reading shows that it does not broaden it substantially.”).

80. John T. Parry, *What Is Torture, Are We Doing It, and What If We Are?*, 64 U. PITT. L. REV. 237, 249 (2003).

81. Sussman, *supra* note 73, at 228. See generally David Sussman, *What’s Wrong with Torture?*, 33 PHIL. & PUB. AFF. 1, 3–5 (2005) (arguing for an account of why torture is morally reprehensible that transcends the mental and physical harms involved, focusing specially on “interrogational torture”).

82. Organization of American States, Inter-American Convention to Prevent and Punish Torture art. 2, Dec. 9, 1985, 25 I.L.M. 519.

“Volunteers who have experienced waterboarding describe the experience as not intensely, physically painful but nevertheless filled with panic and dread.”

it is inflicted for specified purposes: for “criminal investigation, as a means of intimidation, as personal punishment, as a preventive measure, as a penalty, or for any other purpose” other than those incident to lawful sanctions. This Convention illustrates the values component of torture—that physical pain may have less significance than the purpose for which dominance is being exerted and the impact on the mental state of the victim.

While these non-pain-based definitions capture a certain aspect of the issue, they do not grapple with what I would argue remains the essence of torture as an embodied experience. It cannot be the case that a mere disparity in power is sufficient to constitute torture. Asymmetries of power, knowledge, and prerogative are not only common but ubiquitous. In a world of inequalities, power dynamics between subjects are the norm, not the exception.

3. Harms of Torture Beyond Direct Harm to Victims

The liberal theoretical objection to torture offers another approach that is neither narrowly rooted in the victim’s pain nor focused on the victim’s emotional experience, focusing instead on the harms of torture to the body politic. The abhorrence of cruelty, as Judith N. Shklar has argued, only arises with liberal consciousness because physical subjugation of the individual to the *raison d’état* was presumed in earlier periods.⁸³ Norms of respect for the prisoner’s body began to emerge in European society only after the French Revolution.⁸⁴ The writings of statesmen and political philosophers active in the founding of the United States and in the political

underpinnings of the American and French revolutions also had parts to play, making evident that the primary party harmed by torture is the state practicing it. To take one of many examples, Patrick Henry spoke passionately against torture: “What has distinguished our ancestors? That they would not admit of tortures, or cruel and barbarous punishment. But Congress may . . . tell you that there is such a necessity of strengthening the arm of government, that they must . . . extort confession by torture We are then lost and undone.”⁸⁵ As David Luban argues, “torture is a microcosm, raised to the highest level of intensity, of . . . tyrannical political relationships,”⁸⁶ of the elevation of the state (*Staatsraison* or *raison d’état*) over the autonomy and dignity of the individual.⁸⁷ This puts torture in direct opposition to liberal political theory. Rather, the individual’s triumph over the state may be seen as liberalism’s core achievement.⁸⁸

4. Torture, Measurement, and Embodied Morality

Definitions of torture that focus exclusively on degree of bodily pain ultimately mislead because they suggest a measurement fallacy—the fallacy that torture is no more than a lot of pain. Waterboarding provides the paradigmatic example of the shortcomings of and subterfuges permitted by the notion of torture as specific and measurable pain. Volunteers who have experienced waterboarding describe the experience as not intensely, physically painful but nevertheless filled with panic and dread.⁸⁹ Because of the emphasis on physical pain in recent interpretative guidelines governing torture,⁹⁰ proponents of waterboarding and similar practices may argue that it categorically does not constitute torture because it simply does not hurt enough.

Conversely, definitions of torture that abjure a connection to the body’s suffering are overinclusive and fail to account for the status of the body in relation to moral theory and political theory. Thus, both torture and torture-murder show how legal categories defined by pain cannot be reduced to facts about the body yet remain rooted in it through embodied morality.

83. JUDITH N. SHKLAR, *ORDINARY VICES* 43 (1984); see Luban, *Liberalism*, *supra* note 64, at 1429.

84. JAMES Q. WHITMAN, *HARSH JUSTICE: CRIMINAL PUNISHMENT AND THE WIDENING DIVIDE BETWEEN AMERICA AND EUROPE* 9–10 (2003); see also Heikki Pihlajamäki, *The Painful Question: The Fate of Judicial Torture in Early Modern Sweden*, 25 *LAW & HIST. REV.* 557, 582 (2007) (“[T]he idea of respectful treatment of the prisoner only ar[ose] in Europe after the French Revolution.” (footnote omitted)).

85. *THE DEBATES IN THE SEVERAL STATE CONVENTIONS ON THE ADOPTION OF THE FEDERAL CONSTITUTION, AS RECOMMENDED BY THE GENERAL CONVENTION AT PHILADELPHIA, IN 1787*, at 447–48 (Jonathan Elliot ed., 2d ed. 1891 prtg.).

86. Luban, *Liberalism*, *supra* note 64, at 1430.

87. Pihlajamäki, *supra* note 84, at 558 (citing MATHIAS SCHMOECKEL, *HUMANITÄT UND STAATSRATION: DIE ABSCHAFFUNG DER FOLTER IN EUROPA UND DIE ENTWICKLUNG DES GEMEINEN STRAFPROZESS- UND BEWEISRECHTS SEIT DEM HOHEN MITTELALTER* 359, 536, 591 (2000)).

88. See Gerald Gaus & Shane D. Courtland, *Liberalism*, *STAN. ENCYCLOPEDIA OF PHIL.* (Sept. 16, 2010), <http://plato.stanford.edu/entries/liberalism/#PreFavLib> (“The a priori assumption is in

favour of freedom This might be called the Fundamental Liberal Principle: freedom is normatively basic, and so the onus of justification is on those who would limit freedom, especially through coercive means. It follows from this that political authority and law must be justified, as they limit the liberty of citizens.” (citations omitted) (internal quotation marks omitted)); see also JOHN LOCKE, *TWO TREATISES ON GOVERNMENT* § 119, at 291 (1821) (“Every man being . . . naturally free, and nothing being able to put him into subjection to any earthly power, but only his own consent. . . .”); JOHN STUART MILL, *ON LIBERTY* 21–22 (London, Longman, Roberts & Green 2d ed. 1859), *available at* <http://www.bartleby.com/130/index.html> (advocating the limitation of society’s authority over individuals).

89. Memorandum for John A. Rizzo, Senior Deputy General Counsel, Central Intelligence Agency re: Application of 18 U.S.C. §§ 2340-2340A to Certain Techniques That May Be Used in the Interrogation of a High Value al Qaeda Detainee (May 10, 2005), *reprinted in* *THE TORTURE MEMOS: RATIONALIZING THE UNTHINKABLE* 152, 191–96 (David Cole ed., 2009).

90. See sources cited *supra* notes 78–79.

III. CASE STUDY: ACUTE PAIN IN DEATH PENALTY AND ABORTION LAWMAKING

Two highly contentious, current legal controversies appear to be framed exclusively in terms of quanta of pain: Eighth Amendment challenges to the death penalty and limitations on abortion based upon fetal pain. In Eighth Amendment challenges to the death penalty, the battlefield has moved from the constitutionality of execution to the question of whether lethal injection is unconstitutionally painful. In abortion legislation and jurisprudence, the pressing contemporary question has transformed from the constitutionality of access to the procedure to whether the procedure may be limited on the ground that fetuses experience pain. In these areas, the major public claims have shifted from arguments for outright abolition to arguments for pain-limiting restrictions. That is, opponents of these practices argue for their severe curtailment based on the unwarranted degree of pain they cause while supporters either assert that current practices are sufficiently humane or not painful.

These two controversies, at first glance, appear to represent classic instances where empirical information about degree of pain would be dispositive. Yet the terms of the debates themselves show that the appeal to pain is substantially strategic. Guaranteeing complete painlessness in administering abortions and the death penalty would not resolve the abovementioned problems; the abolition debate would simply shift to yet another area. This is not to say that real pain does not count, or that limiting suffering is not in itself a worthy goal; rather, these discourses do not view the limiting of suffering as the primary issue.

A. PAIN-BASED CHALLENGES TO THE DEATH PENALTY

Since 2006, all major anti-death-penalty litigation has focused on Eighth Amendment challenges to the painfulness of lethal injection.⁹¹ Prior to 2006, the Supreme Court had rejected method-of-execution challenges to lethal injection.⁹² Then, in *Hill v. McDonough*, the Court held that petitioners could employ 42 U.S.C. § 1983 to challenge the method of their scheduled lethal injections as a violation of their civil rights.⁹³

The usual claim raised under § 1983 is the following: The most common lethal injection protocol, which involves three

drugs being injected in sequence, sometimes fails. If the drug that induces unconsciousness is not administered successfully, the condemned remains conscious during injection of the final drugs.⁹⁴ Without adequate anesthesia, one such drug, potassium chloride, causes “excruciating pain”⁹⁵ as it “inflames . . . the sensory nerve fibers, literally burning up the veins as it travels to the heart.”⁹⁶ The third drug, pancuronium bromide, is believed to be no less painful.⁹⁷

Post-*Hill* Eighth Amendment challenges to the painfulness of lethal injection have necessarily styled themselves as method-of-execution cases. Yet, they effectively use the claim of pain to challenge the practice of execution itself. This is clearest in *Baze v. Rees*, in which the Supreme Court both clarified and confounded the state of pain-based challenges to lethal injection.⁹⁸ In *Baze*, two Kentucky death-row inmates challenged the state’s lethal injection protocol as unconstitutional because it had the potential to cause a cruel or unusual level of pain.⁹⁹

This surely looked like a purely pain-based challenge in which success on the merits would have done nothing for the petitioners but tweak the execution protocol to which they were entitled. But the petitioners (or their attorneys) had a clever play: they asserted that only physician monitoring would assure an execution sufficiently pain-free to satisfy constitutional standards.¹⁰⁰ However, physicians in Kentucky may not legally assist in any capacity with executions. Since doctors cannot participate in executions, a decision requiring physician monitoring of pain would have the underlying effect of halting executions.¹⁰¹

The Court did not bite. The Court very narrowly held that Kentucky’s execution protocol did not require medical monitoring while reserving judgment as to the constitutionality of

“Two highly contentious, current legal controversies appear to be framed exclusively in terms of quanta of pain: Eighth Amendment challenges to the death penalty and limitations on abortion based upon fetal pain.”

91. See generally Note, *A New Test for Evaluating Eighth Amendment Challenges to Lethal Injections*, 120 HARV. L. REV. 1301, 1301, 1304–06 (2007) (noting that “[a]n explosion of Eighth Amendment challenges to lethal injection protocols has struck the federal courts” and describing such litigation).

92. *Id.* at 1304 (citing *Morales v. Hickman*, 415 F. Supp. 2d 1037, 1043 (N.D. Cal.), *aff’d per curiam*, 438 F.3d 926 (9th Cir. 2006)) (collecting cases).

93. 547 U.S. 573 (2006); see also Douglas A. Berman, *Finding Bickel Gold in a Hill of Beans*, 2005–2006 CATO SUP. CT. REV. 311, 318 (“[T]he Court’s work in *Hill* had a profound nationwide ripple effect on lethal injection litigation and on state efforts to carry out scheduled executions.”). Section 1983 permits a petitioner to challenge the circumstances of a lawfully imposed sentence; thus it is more limited than a habeas claim, which challenges the law-

fulness of the sentence itself. See *Hill*, 547 U.S. at 579.

94. See HUMAN RIGHTS WATCH, *SO LONG AS THEY DIE: LETHAL INJECTIONS IN THE UNITED STATES 21* (2006), available at <http://hrw.org/reports/2006/us0406/us0406web.pdf>.

95. *Brown v. Beck*, No. 5:06CT3018 H, 2006 WL 3914717, at *7 (E.D.N.C. Apr. 7, 2006).

96. HUMAN RIGHTS WATCH, *supra* note 94, at 22.

97. See *AbdurRahman v. Bredesen*, 181 S.W.3d 292, 300, 309, 312–13 (Tenn. 2005) (declining to apply a state animal euthanasia statute to humans but noting the potential painfulness of the challenged substance).

98. 553 U.S. 35, 41, 49–50 (2008).

99. See *id.* at 41.

100. See *id.* at 59.

101. See *id.*

“As death-penalty litigation has evolved toward challenges to the practice’s painfulness, so too has the controversy around another great lightning rod in American politics—abortion.”

the risk and amount of pain incident to the execution protocol of any other state.¹⁰²

Baze shows how pain stands in as a proxy for the larger values and commitments at stake. In bringing a challenge to the degree of painfulness of Kentucky’s execution protocol, the litigants meant to do no less than halt the practice of execution in Kentucky. In deciding *Baze* so narrowly, the Court effectively left the door open not only for future method-of-execution cases but for challenges to the practice of execution itself (regardless of whether intent can be imputed to a fractured court).

At the same time, there is no doubt that the facts of bodily pain also played a non-incident role in *Baze*. At one extreme, if Kentucky’s execution method were demonstrably painless, the litigants could not have styled the case as a pain-based Eighth Amendment challenge. At the other extreme, if the Kentucky execution protocol involved gratuitous pain, no justice could have affirmed it because settled precedent would deem it unconstitutional.¹⁰³

Pain thus played a real role in this question, if only at the extremes. But everything in between these extremes involves clearly normative judgments as to the level of pain a state or a society finds tolerable in the specific context of the death penalty. And it is in this unquantifiable, normative ground that ideological differences between members of the Court emerge. On the one hand, if the punishment of execution equates to the taking of life, execution should be actually painless—anything

else is gratuitous, additional punishment. Justices espousing this view, unsurprisingly, have espoused anti-death-penalty views and have proven instrumental in limiting the application of the death penalty to special populations like juveniles and the intellectually disabled.¹⁰⁴ On the other hand, justices who view pain incident to death as an acceptable part of execution do not find themselves ideologically opposed to the death penalty.¹⁰⁵ The “pain tolerance,” as it were, of justices on both sides of the issue is a reflection of and a proxy for their values.

B. FETAL PAIN AS ABORTION CHALLENGE

As death-penalty litigation has evolved toward challenges to the practice’s painfulness, so too has the controversy around another great lightning rod in American politics—abortion. The strategy of focusing on fetal pain allows the debate to shift away from the endless and irresolvable controversy over personhood. Instead, it permits anti-abortion advocates to propose, along with Bentham, that “[t]he question is not Can they reason?, nor, Can they talk?, but Can they suffer?”¹⁰⁶ In addition to Bentham’s moral question, the disgust factor related to thinking about fetal pain also plays a role, a factor that may be more viscerally effective than the philosophical and rhetorical strategies related to personhood.

The tactic of focusing on pain has had considerable success. In 2010, Nebraska passed the Abortion Pain Prevention Act, which bans abortions of any fetus deemed “pain capable.”¹⁰⁷ The statute establishes a bright-line rule (subject to the typical exceptions)¹⁰⁸ that no abortion may be performed at or after the 20th week of gestation on the ground that such fetuses can experience pain.¹⁰⁹ Arkansas, Georgia, Illinois, Minnesota, and Oklahoma passed inform-and-consent, fetal pain abortion legislation.¹¹⁰ A proposed federal inform-and-consent statute, the Unborn Child Pain Awareness Act, also known as the “Abortion Pain Bill,” nearly passed the House of Representatives in 2006.¹¹¹

102. *Baze*, 553 U.S. at 61-63.

103. See *Gregg v. Georgia*, 428 U.S. 153, 183 (1976) (plurality opinion) (noting that a criminal sanction may not impose “gratuitous infliction of suffering” unrelated to “penological justification”); see also *In re Kemmler*, 136 U.S. 436, 447 (1890) (“Punishments are cruel when they involve torture or a lingering death . . . It implies there [sic] something inhuman and barbarous, something more than the mere extinguishment of life.”).

104. See, e.g., *Roper v. Simmons*, 543 U.S. 551, 575 (2005) (holding that the death penalty is unconstitutional for juvenile offenders); *Atkins v. Virginia*, 536 U.S. 304, 321 (2002) (same with respect to mentally retarded defendants).

105. See, e.g., *Louisiana ex rel. Francis v. Resweber*, 329 U.S. 459, 464 (1947) (permitting a second attempt to execute by electrocution).

106. Katherine E. Engelman, Note, *Fetal Pain Legislation: Protection Against Pain Is Not an Undue Burden*, 10 QUINNIPIAC HEALTH L.J. 279, 279 (2007) (quoting JEREMY BENTHAM, AN INTRODUCTION TO THE PRINCIPLES OF MORALS AND LEGISLATION (Dover Publ’ns 2007) (1789)) (internal quotation marks omitted) (analogizing between Bentham’s animal-welfare argument and positions adopted by those who understand abortion at least partially in terms of a fetus as a rights-bearing entity with a right to be free of pain).

107. The relevant part of this legislation is known as the Pain-Capable Unborn Child Protection Act, 2010 Neb. Laws 874.

108. The statute makes an exception where the abortion is necessary to avert the death or “serious risk of substantial and irreversible physical impairment of a major bodily function” of the mother or to save the life of the unborn child. See *id.* at 875.

109. See *id.*

110. See ARK. CODE ANN. §§ 20-16-1101 to -1111 (2005); GA. CODE ANN. § 31-9A-3(2)(D) (West 2009) (“The physician . . . shall orally inform the female that materials have been provided by the State of Georgia . . . [that] contain information on fetal pain.”); 720 ILL. COMP. STAT. 510/6(6) (2005) (requiring physician to inform pregnant woman of the availability of an anesthetic to “alleviate organic pain to the fetus”); MINN. STAT. ANN. § 145.4242(a)(1)(iv) (West 2011) (requiring that the female be told “whether or not an anesthetic or analgesic would eliminate or alleviate organic pain to the unborn child”); OKLA. STAT. ANN. tit. 63, §§ 1-738.6 to -17 (West 2011) (requiring physician to inform female of state-provided materials containing “information on pain and the unborn child”).

111. H.R. 6099, 109th Cong. (2006); see also H.R. 6099: Unborn Child Pain Awareness Act of 2006, GOVTRACK.US, <http://www.govtrack.us/congress/bill.xpd?bill=h109-6099>.

The Abortion Pain Bill had a similar rationale to those of the state inform-and-consent statutes currently in force, made evident from its requirement that abortion providers make accessible to pregnant women a brochure stating the following:

There is substantial evidence that the process of being killed in an abortion will cause the unborn child pain, even though you receive a pain-reducing drug or drugs. Under [this Act], you have a right to know that there is evidence that the process of being killed in an abortion will cause your unborn child pain.¹¹²

As the language above indicates, repugnance to abortion—not fetal pain itself—is the driving force behind these statutes. These statutes can be understood as symbolic in several ways. First, they do not curtail any significant abortion practice, applying to 1% or less of abortions.¹¹³ Second, they do not conform to the best objective, current science on fetal pain.

The American Medical Association suggests that fetuses cannot experience pain until at least 29 weeks,¹¹⁴ while the British Royal College of Obstetricians and Gynaecologists concludes that fetuses cannot feel pain up until birth because “the fetus never experiences a state of true wakefulness in utero and is kept . . . in a continuous, sleep-like unconsciousness or sedation.”¹¹⁵ Other researchers conclude that fetuses prior to 24 weeks may, like a person in a coma, experience nociception without experiencing pain.¹¹⁶ The 24-week threshold holds significance for another reason: by 24 weeks, the fetus is viable.

In this arena, judgments about the presence and degree of pain align well with moral precommitments. The moral substrate of this discourse makes it highly improbable that any degree of scientific knowledge about fetal pain would materially change basic positions on abortion. For those to whom abortion equals the unjustified taking of human life, knowledge of the presence or absence of fetal pain would not alter their view of its wrongfulness. For those to whom abortion does not constitute the taking of a human life, knowledge of the presence or absence of fetal pain might at the margin change views about abortion timing or protocols but would not alter their central belief that the rights of the individual

trump those of the merely incipient individual. Again, the role of pain in the abortion debate seems best explained by ideologies and moral commitments.

CONCLUSION

The development of neurotechnologies prompts us to reexamine the role that the body, including the brain and brain state, plays within the law. Without opportunities to measure and ascertain brain states like pain, legal discourse about pain can function as both a heuristic and as a set of facts about the body, shifting back and forth between both. When neurotechnology promises the ability to measure pain, it requires us to ask the question of what, precisely, measurement will solve. This forces us to untangle the heuristic nature of pain discourse from its physical, factual bases. Thus, pain neuroimaging not only provides a possible tool for measuring pain but also for separating which types of legal discourse about pain are principally heuristic or principally factual.

This set of technologies will or should lead to a more explicit realization of how culture, as mediated through legal culture, engages in and produces embodied normativity. How we experience the body is shaped by norms; reciprocally, our norms about the body are shaped by physical experience itself. In turn, physical experience provides grounding for defining what constitutes moral or immoral treatment of the bodies of others and what conduct toward the bodies of others valorizes or corrupts our values.

A sense of the normative relationship to the body leads to moral judgments about what is or is not morally permissible conduct. Pain occupies a unique position in this regard ontologically and epistemologically. There is an ontological pri-

“[P]ain neuroimaging not only provides a tool for measuring pain but also for separating which types of legal discourse about pain are principally heuristic or principally factual.”

112. H.R. 6099, § 2902(c)(1)(B). On December 6, 2006, the bill failed in the House of Representatives by roll-call vote, which required a two-thirds majority for the bill to pass. The bill received a 58% majority, failing to pass by 35 votes. There were 250 votes in favor; 162 opposed; 20 voting “present” only. H.R. 6099: Unborn Child Pain Awareness Act of 2006, GOVTRACK.US, <http://www.govtrack.us/congress/bill.xpd?bill=h109-6099> (under “Bill Overview,” click on “view all 1 votes on this bill”). This bill was subsequently reintroduced in the Senate in 2007 and 2011 as the Unborn Child Pain Awareness Act, where it has remained in committee. S. 314, 112th Cong. (2011); S. 356, 110th Cong. (2007).

113. The inform-and-consent statutes and Nebraska’s ban (entitled the Pain-Capable Unborn Child Act) apply only to abortions performed at or after the 20th week of gestation. Such late-term procedures account for just over 1% of all abortions in the United States. See *Facts on Induced Abortion in the United States*, GUTTMACHER INST. (Aug. 2011), <http://www.guttmacher.org/>

pubs/fb_induced_abortion.html. About 90% of abortions in the United States take place at or prior to 12 weeks’ gestation. See *id.*

114. See Susan J. Lee et al., *Fetal Pain: A Systematic Multidisciplinary Review of the Evidence*, 294 JAMA 947, 947 (2005). Behavioral studies have shown that neonatal facial movements in response to invasive procedures at 28 to 30 weeks mimic those of adults experiencing pain. See *id.* at 950. Premature infants born at 28 weeks or earlier may also feel pain. See ROYAL COLL. OF OBSTETRICIANS & GYNAECOLOGISTS, FETAL AWARENESS: REVIEW OF RESEARCH AND RECOMMENDATIONS FOR PRACTICE 9, 23 (2010), available at <http://www.rcog.org.uk/files/rcog-corp/RCOGFetalAwareness-WPR0610.pdf> [hereinafter RCOG Report]. Hormonal, environmental, and neurological changes brought about by birth account for these differences between pain perception in an in-utero fetus and one born at the same gestational age. See *id.* at 10.

115. RCOG Report, *supra* note 114, at viii.

116. See Lee et al., *supra* note 114; RCOG Report, *supra* note 114. See generally sources cited *supra* notes 113-114.

macy to pain because it is through the suffering of the self that we understand the wrongfulness of causing gratuitous suffering to others; some of this is direct, empathic, and likely physiological. In a sense, such reasoning is grounded in the body's physicality. And yet, it is also grounded in the body's status within the nomos, which is informed by—but not coextensive with—physiological experience. The experience of the body, both of self and “other,” is also contingent. Sociohistorical context defines which “others” are seen as sufficiently like the self such that their pain experience is credited as real; once categorized, they are deemed deserving of protection from pain. Since such questions as “who can suffer?” and “whose suffering counts?” define the membership of the community of empathic inclusion, they also define what degree of treatment toward particular legal subjects (whether humans, human fetuses, animals, conscious machines, and others yet to be named) is permissible.

Though primarily normative determinations about status, these questions also involve factual determinations of bodily capacities and of the subject's relationship (if any) to its embodiment. In these ways, the question of pain neuroimaging shows that there must always be significant translational work in moving from neuroimaging technologies to their legal uses and implications. Questions in law about or involving the body (perhaps particularly questions about the brain) are rarely pure questions of fact or value. Rather, we must understand the heuristic and normative role of the law's body-language—of

the embodied morality implicit within the law—to properly understand if, when, and how to adapt the findings of brain imaging to bodies of legal doctrine. Knowledge of what causes the body to suffer informs what a society views as moral or immoral treatment of the person; nevertheless, simple measurement can never resolve fundamental questions about just treatment.



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The Status of NeuroLaw:

A Plea for Current Modesty and Future, Cautious Optimism

Stephen J. Morse, J.D., Ph.D.

In a 2002 editorial published in *The Economist*, the following warning was given: “Genetics may yet threaten privacy, kill autonomy, make society homogeneous and gut the concept of human nature. But neuroscience could do all of these things first.”¹ The genome was fully sequenced in 2001, and there has not been one resulting major advance in therapeutic medicine since. Thus, even in its most natural applied domain—medicine—genetics has not had the far-reaching consequences that were envisioned.² The same has been true of various other sciences that were predicted to revolutionize the law, including behavioral psychology, sociology, and psychodynamic psychology, to name but a few. This will also be true of neuroscience, which is simply the newest science on the block. Neuroscience is not going to do the terrible things *The Economist* fears, at least not in the foreseeable future. Neuroscience has many things to say, but not nearly as much as people would hope, especially in relation to law. At most, in the near to intermediate term, neuroscience may make modest contributions to legal policy and case adjudication. Nonetheless, there has been irrational exuberance about the potential contribution of neuroscience, an issue I have addressed previously and referred to as “brain overclaim syndrome.”³

I first address the law’s motivation and the motivation of some advocates to turn to science to solve the very hard normative problems that law addresses. The next part discusses the law’s psychology and its concepts of the person and responsibility. Then I consider the general relation of neuroscience to law, which I characterize as the issue of “translation.” The following part canvasses various distractions that have bedeviled clear thinking about the relation of scientific, causal accounts of behavior to responsibility. Next, I examine the limits of neuro-law and consider why neurolaw does not pose a genuinely radical challenge to the law’s concepts of the person and responsibility. The penultimate part makes a case for cautious optimism about the contribution that neuroscience may make to law in the near and intermediate term. A brief conclusion follows.

THE SOURCE OF NEUROEXUBERANCE

Everyone understands that legal issues are normative,

addressing how we should regulate our lives in a complex society. How do we live together? What are the duties we owe each other? For violations of those duties, when is the state justified in imposing the most afflictive—but sometimes warranted—exercises of state power, criminal blame, and punishment?⁴ When should we do this, to whom, and how much?

Virtually every legal issue is contested—consider criminal responsibility, for example—and there is always room for debate about policy, doctrine, and adjudication. In a recent book, Professor Robin Feldman has argued that law lacks the courage forthrightly to address the difficult normative issues that it faces.⁵ The law therefore adopts what Feldman terms an “internalizing” and an “externalizing” strategy for using science to try to avoid the difficulties. In the internalizing strategy, the law adopts scientific criteria as legal criteria. A futuristic example might be using neural criteria for criminal responsibility. In the externalizing strategy, the law turns to scientific or clinical experts to make the decision. An example would be using forensic clinicians to decide whether a criminal defendant is competent to stand trial and then simply rubberstamping the clinician’s opinion.⁶ Neither strategy is successful, because each avoids facing the hard questions and impedes legal evolution and progress. Professor Feldman concludes, and I agree, that the law does not err by using science too little, as is commonly claimed. Rather, it errs by using it too much because the law is too insecure about its resources and capacities to do justice.

A fascinating question is why so many enthusiasts seem to have extravagant expectations about the contribution of neuroscience to law, especially criminal law. Here is my speculation about the source. Many people intensely dislike the concept and practice of retributive justice, thinking that they are prescientific and harsh. Their hope is that the new neuroscience will convince the law at last that determinism is true, no offender is genuinely responsible, and the only logical conclusion is that the law should adopt a consequentially based prediction/prevention system of social control guided by the knowledge of the neuroscientist-kings who will finally have supplanted the platonic philosopher-kings.⁷ On a more modest level, many advocates think that neuroscience may not revolutionize criminal

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Footnotes

1. *The Ethics of Brain Sciences: Open Your Mind*, *Economist*, May 25, 2002, at 77.
2. See, e.g., Robert Koenig, *Genome Scans: Impatient for the Payoff*, 324 *Sci.* 448 (2009); Nicolas Wade, *Genes Show Limited Value in Predicting Disease*, *N.Y. Times*, Apr. 16, 2009, at A1.

3. Stephen J. Morse, *Brain Overclaim Syndrome and Criminal Responsibility: A Diagnostic Note*, 3 *OHIO ST. J. CRIM. L.* 397 (2006).
4. See, e.g., *In re Winship*, 397 U.S. 358, 364 (1970) (holding that due process requires that every conviction be supported by proof beyond reasonable doubt as to every element of the crime).
5. ROBIN FELDMAN, *THE ROLE OF SCIENCE IN LAW* (2009).
6. Morse, *supra* note 3.
7. Joshua Greene & Jonathan Cohen, *For the Law, Neuroscience Changes Nothing and Everything*, in *LAW AND THE BRAIN* 217–18, 224 (Samir Zeki & Oliver Goodenough eds., 2006).

justice, but neuroscience will demonstrate that many more offenders should be excused and do not deserve the harsh punishments imposed by the United States criminal justice system. Four decades ago, our criminal justice system would have been using psychodynamic psychology for the same purpose. More recently, genetics has been employed in a similar manner. The impulse, however, is clear: jettison desert, or at least mitigate judgments of desert. As will be shown below, however, these advocates often adopt an untenable theory of mitigation or an excuse that quickly collapses into the nihilistic conclusion that no one is really criminally responsible.

THE LAW'S PSYCHOLOGY, CONCEPT OF THE PERSON, AND RESPONSIBILITY

Criminal law presupposes a “folk-psychological” view of the person and behavior. This psychological theory explains behavior in part by mental states such as desires, beliefs, intentions, willingness, and plans. Biological and other psychological and sociological variables also play a causal role, but folk psychology considers mental states fundamental to a full causal explanation and understanding of human action. Lawyers, philosophers, and scientists argue about the definitions of mental states and theories of action, but that does not undermine the general claim that mental states are fundamental. Indeed, the arguments and evidence that disputants use to convince others presuppose the folk-psychological view of the person. Brains do not convince each other, people do. Folk psychology presupposes only that human action can be rationalized by mental state explanations or will be in response to reasons—including incentives—under the right conditions.

For example, the folk-psychological explanation for why you are reading this article is, roughly, that you desire to understand the relation of neuroscience to criminal responsibility or to law generally. You believe that reading the article will help fulfill that desire, so you formed the intention to read it. This is a practical, rather than a deductive, syllogism. Brief reflection should indicate that the law's psychology must be a folk-psychological theory, a view of the person as a conscious—and potentially self-conscious—creature who forms and acts on intentions that are the product of the person's other mental states. We are the sort of creatures who can act for and respond to reasons. The law treats persons generally as intentional creatures and not simply as mechanistic forces of nature.

Law is primarily action-guiding and is not able to guide people directly and indirectly unless people are capable of using rules as premises in their reasoning about how they should behave. Unless people could be guided by law, it would be useless (and perhaps incoherent) as an action-guiding system of rules. Legal rules are action-guiding primarily because these rules provide an agent with good moral or prudential reasons for forbearance or action. Human behavior can be modified by means other than influencing deliberation, and human beings do not always deliberate before they act. Nonetheless, the law presupposes folk psychology even when we most habitually follow the legal rules. Unless people are capable of understanding and then using legal rules to guide their conduct, the law is powerless to affect human behavior.

The legal view of the person does not hold that people must always reason or consistently behave rationally according to

some preordained, normative notion of rationality. Rather, the law's view is that people are both capable of acting for reasons and capable of minimal rationality according to predominantly conventional, socially constructed standards. The type of rationality the law requires is the ordinary person's common-sense view of rationality, not the technical notion that might be acceptable within the disciplines of economics, philosophy, psychology, computer science, and the like.

Virtually everything for which agents deserve to be praised, blamed, rewarded, or punished is the product of mental causation and, in principle, is responsive to reasons, including incentives. Machines may cause harm, but they cannot do wrong, and they cannot violate expectations about how people ought to live together. Machines do not deserve praise, blame, reward, punishment, concern, or respect because they exist or because of the results they cause. Only people, intentional agents with the potential to act, can do wrong and violate expectations of what they owe each other.

Many scientists and some philosophers of mind and action might consider folk psychology to be a primitive or prescientific view of human behavior. For the foreseeable future, however, the law will be based on the folk-psychological model of the person and behavior described. Until and unless scientific discoveries convince us that our view of ourselves is radically wrong, the basic explanatory apparatus of folk psychology will remain central. It is vital that we not lose sight of this model lest we fall into confusion when various claims based on neuroscience are made. If any science is to have appropriate influence on current law and legal decision-making, the science must be relevant to and translated into the law's folk-psychological framework (as shall be discussed in more detail below).

All of the law's doctrinal criteria for criminal responsibility are folk psychological. Begin with the definitional criteria, the elements of crime. The “voluntary” act requirement is defined, roughly, as an intentional bodily movement—or omission in cases in which the person has a duty to act—done in a reasonably integrated state of consciousness. Other than crimes of strict liability, all crimes also require a culpable mental state, such as purpose, knowledge, or recklessness. All affirmative defenses of justification and excuse involve an inquiry into the person's mental state, such as the belief that self-defensive force was necessary, or the lack of knowledge of right from wrong.

Our folk-psychological concepts of criminal responsibility follow logically from the action-guiding nature of law itself, from its folk-psychological concept of the person and action, and from the aim of achieving retributive justice, which holds that no one should be punished unless they deserve it and punished no more than they deserve. The general capacity for rationality is the primary condition for responsibility, and the lack of that capacity is the primary condition for excusing a person. If human beings were not rational creatures who could understand the good reasons for action and were not capable of conforming to legal requirements through intentional action or for-

“Criminal law presupposes a ‘folk-psychological’ view of the person and behavior.”

“The question is whether the new neuroscience is legally relevant. . . .”

bearance, the law could not adequately guide action and would not be just. Legally responsible agents are therefore people who have the general capacity to grasp and be guided by good reason in particular legal contexts.⁸

In cases of excuse, the agent who has done something wrong acts for a reason, but is either incapable of rationality generally or incapable on the specific occasion in question. This explains, for example, why young children and some people with mental disorders are not held responsible. The lack of capacity for rationality that is necessary to find the agent not responsible is a moral, social, political and, ultimately, legal issue. It is not a scientific, medical, psychological, or psychiatric issue.

Compulsion or coercion is also an excusing condition. Literal compulsion exists when the person's bodily movement is a pure mechanism that is not rationalizable by reference to the agent's mental states. These cases defeat the requirement of a “voluntary act.” For example, a tremor or spasm produced by a neurological disorder is not an action because it is not intentional and, therefore, defeats the ascription of a voluntary act. Metaphorical compulsion exists when an agent acts intentionally, but in response to some hard choice imposed on the agent through no fault of his or her own. For example, if a miscreant holds a gun to an agent's head and threatens to kill her unless she kills another innocent person, it would be wrong for her to kill under these circumstances. Nevertheless, the law may decide as a normative matter to excuse the act of intentional killing because the agent was motivated by a threat so great that it would be supremely difficult for most citizens to resist. Cases involving internal compulsive states are more difficult to conceptualize because it is difficult to define and assess loss of control.⁹ The cases that most fit this category are “disorders of desire,” such as addictions and sexual disorders. The question is why these acting agents lack control, but other people with strong desires do not. If people frequently yield to their apparently very strong desires at great social, medical, occupational, financial, and legal cost to themselves, agents will often say they could not help themselves, they were not in control, and an excuse or mitigation is therefore warranted. But why mitigation or excuse should obtain is difficult to understand.

LOST IN TRANSLATION? LEGAL RELEVANCE AND THE NEED FOR TRANSLATION

What in principle is the possible relation of neuroscience to law? We must begin with a distinction between internal relevance and external relevance. An internal contribution or critique accepts the general coherence and legitimacy of a set of

legal doctrines, practices, or institutions, and attempts to explain or alter them. For example, an internal contribution to criminal responsibility may suggest the need for doctrinal reform of, say, the insanity defense, but it would not suggest that the notion of criminal responsibility is itself incoherent or illegitimate. By contrast, an externally relevant critique suggests that the doctrines, practices, or institutions are incoherent, illegitimate, or unjustified. Because a radical, external critique has little possibility of success at present (as is explained below), I make the simplifying assumption that the contributions of neuroscience will be internal and thus will need to be translated into the law's folk-psychological concepts.

The law's criteria for responsibility and competence are essentially behavioral—acts and mental states. The criteria of neuroscience are mechanistic—neural structure and function. Is the apparent chasm between those two types of discourse bridgeable? This is a familiar question in the field of mental health law,¹⁰ but there is even greater dissonance in neurolaw. Psychiatry and psychology sometimes treat behavior mechanistically, sometimes treat it folk psychologically, and sometimes blend the two. In many cases, the psychological sciences are quite close to folk psychology in approach. Neuroscience, in contrast, is purely mechanistic and eschews folk-psychological concepts and discourse. Neurons and neural networks do not act intentionally for reasons. They have no sense of past, present, and future, and no aspirations. Thus, the gap will be harder to bridge.

The brain does enable the mind (even if we do not know how this occurs). Therefore, facts we learn about brains in general or about a specific brain could in principle provide useful information about mental states and about human capacities in general and in specific cases. Some believe that this conclusion is a category error.¹¹ This is a plausible view, and perhaps it is correct. If it is, then the whole subject of neurolaw is empty, and there was no point in writing this article in the first place. Let us therefore bracket this pessimistic view and determine what follows from the more optimistic position that what we learn about the brain and nervous system can be potentially helpful to resolving questions of criminal responsibility if the findings are properly translated into the law's psychological framework.

The question is whether the new neuroscience is legally relevant because it makes a proposition about responsibility or competence more or less likely to be true. Any legal criterion must be established independently, and biological evidence must be translated into the criminal law's folk-psychological criteria. That is, the expert must be able to explain precisely how the neuroevidence bears on whether the agent acted, formed the required *mens rea*, or met the criteria for an excusing condition. In the context of competence evaluations, the expert must explain precisely how the neuroevidence bears on

8. I adapt the felicitous phrase “to grasp and be guided by good reason” from JAY WALLACE, *RESPONSIBILITY AND THE MORAL SENTIMENTS* 86 (1994).

9. Stephen J. Morse, *Uncontrollable Urges and Irrational People*, 88 VA. L. REV. 1025, 1035 (2002).

10. See, e.g., ALAN A. STONE, *LAW, PSYCHIATRY, AND MORALITY* 95–96

(1984).

11. See, e.g., MAX R. BENNETT & PETER M.S. HACKER, *PHILOSOPHICAL FOUNDATIONS OF NEUROSCIENCE* 112, 270, 360, 381 (2003); Michael S. Pardo & Dennis Patterson, *Philosophical Foundations of Law and Neuroscience*, U. ILL. L. REV. 1211 (2010).

whether the subject was capable of meeting the law's functional criteria. If the evidence is not directly relevant, the expert should be able to explain the chain of inference from the indirect evidence to the law's criteria. At present, as I explain below, few such data exist, but neuroscience is advancing so rapidly that such data may exist in the near or medium term. Moreover, the argument is conceptual and does not depend on any particular neuroscience findings.

DANGEROUS DISTRACTIONS CONCERNING NEUROSCIENCE AND CRIMINAL RESPONSIBILITY AND COMPETENCE

This part considers a number of related issues that are often thought to be relevant to criminal responsibility and competence but that are in fact irrelevant, confusing, and distracting: free will, causation as an excuse, causation as compulsion, prediction as an excuse, dualism, and the non-efficacy of mental states. It is important to correct these errors because much of the unjustified legal exuberance about the contributions of neurolaw flows from them. The legal exuberance also flows, however, from unrealistic expectations about the scientific accomplishments of neuroscience. A later part of this article addresses the scientific exuberance.

Contrary to what many people believe and what judges and others sometimes say, free will is not a legal criterion that is part of any doctrine, and it is not even foundational for criminal responsibility.¹² Criminal law doctrines are fully consistent with the truth of determinism or universal causation that allegedly undermine the foundations of responsibility. Even if determinism is true, some people act and some people do not. Some people form prohibited mental states and some do not. Some people are legally insane or act under duress when they commit crimes, but most defendants are not legally insane or acting under duress. Moreover, these distinctions matter to moral and legal theories of responsibility and fairness that we have reason to endorse. Thus, law addresses problems genuinely related to responsibility, including consciousness, the formation of mental states such as intention and knowledge, the capacity for rationality, and compulsion. The law, however, never addresses the presence or absence of free will.

When most people use the term "free will" in the context of legal responsibility, they are typically using it loosely as a synonym for the conclusion that the defendant was or was not criminally responsible. They typically have reached this conclusion for reasons that do not involve free will—for example, that the defendant was legally insane or acted under duress—but such use of the term only perpetuates misunderstanding and confusion. Once the legal criteria for an excuse have been met—and no excuse includes lack of free will as a criterion—the defendant will be excused without any reference whatsoever to free will as an independent ground for the excuse.

There is a genuine metaphysical problem regarding free will, which is whether human beings have the capacity to act uncaused by anything other than themselves and whether this

capacity is a necessary foundation for holding anyone legally or morally accountable for criminal conduct. Philosophers and others have debated these issues in various forms for millennia and there is no resolution in sight. Indeed, some people might think that the problem is insoluble. This is a philosophical issue, but it is not a problem for the law, and neuroscience raises no new challenge to this conclusion. Solving the metaphysical free-will problem might have profound implications for responsibility doctrines and practices, such as blame and punishment, but having or lacking libertarian freedom is not a criterion of any civil or criminal law doctrine.

Neuroscience is simply the most recent, mechanistic causal science that appears deterministically to explain behavior. Neuroscience thus joins social structural variables, behaviorism, genetics, and other scientific explanations that have also been deterministic explanations for behavior. In principle, however, neuroscience adds nothing new, even if neuroscience is a better, more persuasive science than some of its predecessors. No science, including neuroscience, can demonstrate that libertarian free will does or does not exist. As long as free will in the strong sense is not foundational for just blame and punishment and is not a criterion at the doctrinal level—which it is not—the truth of determinism or universal causation poses no threat to legal responsibility. Neuroscience may help shed light on folk-psychological excusing conditions, such as automatism or legal insanity, but the truth of determinism is not an excusing condition. The law will be fundamentally challenged only if neuroscience or any other science can conclusively demonstrate that the law's psychology is wrong and that we are not the type of creatures for whom mental states are causally effective. This is a different question from whether determinism undermines responsibility, however, and this article returns to it below.

A related confusion is that behavior is excused if it is caused, but causation per se is not a legal or moral mitigating or excusing condition. I termed this confusion the "fundamental psycholegal error."¹³ At most, causal explanations can only provide evidence concerning whether a genuine excusing condition, such as lack of rational capacity, was present. For example, suppose a life marked by poverty and abuse played a predisposing causal role in a defendant's criminal behavior or that an alleged new mental syndrome played a causal role in explaining criminal conduct. The claim is often made that such causes—for which the agent is not responsible—should be an excusing or mitigating position per se, but this claim is false.

All behavior is the product of the necessary and sufficient

“[F]ree will is not a legal criterion that is part of any doctrine, and it is not even foundational for criminal responsibility.”

12. Stephen J. Morse, *The Non-Problem of Free Will in Forensic Psychiatry and Psychology*, 25 BEHAV. SCI. & L. 203, 204 (2007).

13. Stephen J. Morse, *Culpability and Control*, 142 U. PA. L. REV. 1587, 1592–1694 (1994).

“If causation was the equivalent of compulsion, all behavior would be compelled and no one would be responsible.”

causal conditions without which the behavior would not have occurred, including brain causation, which is always part of the causal explanation for any behavior. If causation were an excusing condition per se, then no one would be responsible for any behavior. Some people might welcome such a conclusion and believe that responsibility is impossible, but this is not the legal and moral world we inhabit.

The law holds most adults responsible for most of their conduct, and genuine excusing conditions are limited. Thus, unless the person's history or mental condition, for example, provides evidence of an existing excusing or mitigating condition, such as lack of rational capacity, there is no reason for excuse or mitigation.

Even a genuinely abnormal cause is not per se an excusing condition. For example, imagine an armed robber who suffers from intermittent hypomania and who only robs when he is clinically hypomanic because only then does he feel sufficiently energetic and confident. In other words, the hypomania is a “but for” cause of his robberies. Nevertheless, he would not be excused for an armed robbery because hypomania seldom compromises rational capacity sufficiently to warrant an excuse. If he committed an armed robbery under the influence of a delusional belief his mania produced, then he might be excused by reason of legal insanity. In that case, the excusing condition would be compromised rationality and not the mania per se. In short, a neuroscientific causal explanation for criminal conduct, like any other type of causal explanation, does not per se mitigate or excuse. It only provides evidence that might help the law resolve whether a genuine excuse existed, or it may in the future provide data that might be a guide to prophylactic or rehabilitative measures.

Compulsion is a genuine mitigating or excusing condition, but causation—including brain causation—is not the equivalent of compulsion. As we have seen, compulsion may be either literal or metaphorical and normative. It is crucial to recognize that most human action is not plausibly the result of either type of compulsion, but all human behavior is caused by its necessary and sufficient causes—including brain causation. Even abnormal causes are not necessarily compelling. To illustrate, suppose that a person has weak pedophilic urges and weak sexual urges in general. If this person molested a child, there would be no ground for a compulsion excuse. If causation was the equivalent of compulsion, all behavior would be compelled and no one would be responsible. Once again, this is not a plausible account of the law's responsibility conditions. Causal information from neuroscience might help us resolve questions concerning whether legal compulsion existed, or it might be a guide to prophylactic or rehabilitative measures

when dealing with plausible legal compulsion. Causation, however, is not per se compulsion.

Causal knowledge, whether from neuroscience or any other science, can enhance the accuracy of behavioral predictions, but predictability is also not a per-se excusing or mitigating condition—even if the predictability of the behavior is perfect. To understand this, consider how many things we do that are perfectly predictable but for which there is no plausible excusing or mitigating condition. If the variables that enhance prediction also produce a genuine excusing or mitigating condition, then excuse or mitigation is justified for the latter reason and independent of the prediction.

For example, recent research demonstrates that a history of childhood abuse coupled with a specific, genetically produced enzyme abnormality that produces a neurotransmitter deficit vastly increases the risk that a person will behave antisocially as an adolescent or young adult.¹⁴ Does this mean that an offender with this gene-by-environment interaction is not responsible or less responsible? No. The offender may not be fully responsible or responsible at all, but not because there is a causal explanation. What is the intermediary excusing or mitigating principle? Are these people, for instance, more impulsive? Are they lacking rationality? What is the actual excusing or mitigating condition?

Again, causation is not compulsion, and predictability is not an excuse. Just because an offender is caused to do something or is predictable does not mean that the offender was compelled to do the crime charged or is otherwise not responsible. Brain causation—or any other kind of causation—does not mean that we are automatons, not really acting agents at all, or otherwise excused.

Most informed people are not dualists concerning the relation between the mind and the brain. That is, they no longer think that our minds—or souls—are independent of our brains and bodies more generally and can somehow exert a causal influence over our bodies. It may seem as if law's emphasis on the importance of mental states as causing behavior is based on a prescientific, outmoded form of dualism, but this is not the case. Although the brain enables the mind, we have no idea how this occurs and have no idea how action is possible.¹⁵

It is clear that, at the least, mental states are dependent upon or supervene on brain states, but neither neuroscience nor any other science has demonstrated that mental states do not play an independent and partially causal role.

Despite our lack of understanding of the mind-brain-action relation, some scientists and philosophers question whether mental states have any causal effect, thus treating mental states as psychic appendixes that evolution has created but that have no genuine function. These claims are not strawpersons. They are made by serious, thoughtful people.¹⁶ As discussed below, if accepted, they would create a complete and revolutionary paradigm shift in the law of criminal responsibility and competence (and more widely). Thus, this claim is an external critique and must be understood as such. Moreover, given our

14. See, e.g., Avshalom Caspi et al., *Role of Genotype in the Cycle of Violence in Maltreated Children*, 297 *SCI.* 851 (2002). Indeed, the risk is nine times higher.

15. PAUL R. MCHUGH & PHILLIP R. SLAVNEY, *THE PERSPECTIVES OF PSYCHIATRY* 11–12 (2d ed. 1998).

16. See, e.g., Greene & Cohen, *supra* note 7, at 217, 218.

current state of knowledge, there is little scientific or conceptual reason to accept it.¹⁷

In conclusion, legal actors concerned with criminal law policy, doctrine, and adjudication must always keep the folk-psychological view present in their minds when considering claims or evidence from neuroscience, and must always question how the science is legally relevant to the law's action and mental states criteria. The truth of determinism, causation, and predictability do not in themselves answer any doctrinal or policy issue.

THE LIMITS OF NEUROLAW: THE PRESENT LIMITS OF NEUROSCIENCE

Most generally, the relation of brain, mind, and action is one of the hardest problems in all of science. Again, we have no idea how the brain enables the mind or how action is possible.¹⁸ The brain-mind-action relation is a mystery. For example, we would like to know the difference between a neuromuscular spasm and intentionally moving one's arm in exactly the same way. The former is a purely mechanical motion, whereas the latter is an action, but we cannot explain the difference between the two. We know that a functioning brain is a necessary condition for having mental states and for acting. After all, if your brain is dead, you have no mental states, are not acting, and indeed are not doing much of anything at all. Still, we do not know how mental states and action are caused.

Despite the astonishing advances in neuroimaging and other neuroscientific methods, we still do not have sophisticated causal knowledge of how the brain works generally, and we have little information that is legally relevant. This is unsurprising. The scientific problems are fearsomely difficult. Only in the last decade have researchers begun to accumulate much data from functional magnetic resonance imaging (fMRI), which is the technology that has generated most of the legal interest. Moreover, virtually no studies have been performed to address specifically legal questions.

Before turning to the specific reasons for neuromodesty, a few preliminary points of general applicability must be addressed. The first and most important is contained in the message of the prior part. Causation by biological variables, including abnormal biological variables, does not per se create an excusing or mitigating condition. Any excusing condition must be established independently. The goal is always to translate the biological evidence into the criminal law's folk-psychological criteria.

Assessing criminal responsibility involves a retrospective evaluation of the defendant's mental states at the time of the crime. No criminal wears a portable scanner or other neurode-

tection device that provides a measurement at the time of the crime, at least not yet. Further, neuroscience is insufficiently developed to detect specific, legally relevant mental content or to provide a sufficiently accurate diagnostic marker for even a severe mental disorder.¹⁹ Nevertheless, certain aspects of neural structure and function that bear on legally relevant capacities, such as the capacity for rationality and control, may be temporally stable in general or in individual cases. If they are, neuroevidence may permit a reasonably valid retrospective inference about the defendant's rational and control capacities and their impact on criminal behavior. This will of course depend on the existence of adequate science to do this. We currently lack such science, but future research may provide the necessary data.

Questions concerning competence or predictions of future behavior are based on a subject's present condition. Thus, the problems besetting the retrospective responsibility analysis do not apply to such issues. The criteria for competence are functional. They ask whether the subject can perform some task—such as understanding the nature of a criminal proceeding or understanding a treatment option that is offered—at a level the law considers normatively acceptable to warrant respecting the subject's choice and autonomy.

Now, let us consider the specific grounds for neuromodesty in cognitive and social neuroscience, the subdisciplines most relevant to law. At present, most neuroscience studies on human beings involve very small numbers of subjects, although this phenomenon is starting to change. Most of the studies have been done on college and university students, who are hardly a random sample of the population generally and of criminal offenders specifically. There is also a serious question of whether findings based on subjects' behavior and brain activity in a scanner would apply to real world situations. Further, most studies average the neurodata over the subjects, and the average finding may not accurately describe the brain structure or function of any actual subject in the study. Replications are few, which is especially important for law. Policy and adjudication should not be influenced by findings that are insufficiently established, and replications of findings are crucial to our confidence in a result. Finally, the neuroscience of cognition and interpersonal behavior is largely in its infancy and what is known is quite coarse-grained and correlational, rather than fine-grained and causal.²⁰ What is being investigated is an association between a task in the scanner and brain

“[T]he relation of brain, mind, and action is one of the hardest problems in all of science.”

17. Stephen J. Morse, *Lost in Translation? An Essay on Law and Neuroscience*, in *LAW AND NEUROSCIENCE* 543–54 (Michael Freeman ed., 2011).

18. See MCHUGH & SLAVNEY, *supra* note 15.

19. Allen Frances, *Whither DSM-V?*, 195 *BRIT. J. PSYCHIATRY* 391 (2009). Many studies do find differences between patients with mental disorders and controls, but the differences are too small to be used diagnostically. *But see generally* John P.A. Ioannidis, *Excess Significance Bias in the Literature on Brain Volume Abnormalities*,

68 *ARCHIVES GEN. PSYCHIATRY* 773 (2011) (claiming, based on a meta-analysis of studies of brain volume abnormalities in patients with mental disorders, that many more studies than should be expected found statistically significant results and that this can be best explained by bias in the reporting of the data).

20. See, e.g., Gregory A. Miller, *Mistreating Psychology in the Decades of the Brain*, 5 *PERSP. PSYCHOL. SCI.* 716 (2010) (providing a cautious, thorough overview of the scientific and practical problems facing cognitive and social neuroscience).

“Virtually all neuroscience studies of potential interest to the law involve some behavior that has already been identified as of interest. . . .”

activity. These studies do not demonstrate that the brain activity is either a necessary, sufficient or predisposing causal condition for the behavioral task that is being done in the scanner. Any language that suggests otherwise—such as claiming that some brain region is the neural substrate for the behavior—is simply not justifiable based on the methodol-

ogy of most studies. Moreover, activity in the same region may be associated with diametrically opposite behavioral phenomena—for example, love and hate.

There are also technical and research design difficulties. It takes many mathematical transformations to get from the raw fMRI data to the images of the brain that are increasingly familiar. Explaining these transformations is beyond me, but I do understand that the likelihood that an investigator will find a statistically significant result depends on how the researcher sets the threshold for significance. There is dispute about this, and the threshold levels are conventional. If the threshold changes, so does the outcome. I have been convinced by neuroscience colleagues that many such technical difficulties have largely been solved, but research design and potentially unjustified inferences from the studies are still an acute problem. It is extraordinarily difficult to control for all conceivable artifacts. Consequently, there are often problems of over-inference. Finally, it is also an open question whether accurate inferences or predictions about individuals are possible using group data when that group includes the individual. This is a very controversial topic, but even if it is difficult or impossible now, it may become easier in the future. Over time, however, all these problems may ease as imaging and other techniques become less expensive and more accurate, research designs become more sophisticated, and the sophistication of the science increases generally.

Virtually all neuroscience studies of potential interest to the law involve some behavior that has already been identified as of interest, and the point of the study is to identify that behavior’s neural correlates. Neuroscientists do not go on general fishing expeditions.²¹ There is usually some bit of behavior—such as addiction, schizophrenia, or impulsivity—that investigators would like to understand better by investigating its neural correlates. To do this properly presupposes that the researchers have already identified and validated the behavior under neuroscientific investigation. Thus, neurodata can be no more valid than the behavior with which it is correlated.

On occasion, the neuroscience might suggest that the behavior is not well characterized, or is neurally indistinguish-

able from other, seemingly different behavior. In general, however, the existence of legally relevant behavior will already be apparent before the neuroscientific investigation is begun. For example, some people are grossly out of touch with reality. If, as a result, they do not understand right from wrong, we excuse them because they lack such knowledge. We might learn a great deal about the neural correlates of such psychological abnormalities, but we already knew without neuroscientific data that these abnormalities existed, and we had a firm view of their normative significance. In the future, however, we may learn more about the causal link between the brain and behavior, and studies may be devised that are more directly legally relevant. I suspect that we are unlikely to make substantial progress with neural assessment of legally relevant mental content, but we are likely to learn more about capacities that will bear on excuse or mitigation.

The criteria for both responsibility and competence are behavioral; therefore, actions speak louder than images. This is a truism for all criminal responsibility and competence assessments. If the finding of any test or measurement of behavior is contradicted by actual behavioral evidence, then we must believe the behavioral evidence because it is more direct and probative of the law’s behavioral criteria. For example, if the person behaves rationally in a wide variety of circumstances, the agent is rational even if the brain appears structurally or functionally abnormal. We confidently knew that some people were behaviorally abnormal—such as being psychotic—long before there were any psychological or neurological tests for such abnormalities.

An analogy from physical medicine may be instructive. Suppose someone complains about back pain, a subjective symptom, and the question is whether the subject actually does have back pain. We know that many people with abnormal spines do not experience back pain, and many people who complain of back pain have normal spines. If the person is claiming a disability and the spine looks dreadful, evidence that the person regularly exercises on a trampoline without difficulty indicates that there is no disability caused by back pain. If there is reason to suspect malingering, however, and there is not clear behavioral evidence of lack of pain, then a completely normal spine might be of use in deciding whether the claimant is malingering. Unless the correlation between the image and the legally relevant behavior is very powerful, however, such evidence will be of limited help.

If actions speak louder than images, however, what room is there for introducing neuroevidence in legal cases? Let us begin with cases in which the behavioral evidence is clear and permits an equally clear inference about the defendant’s mental state. For example, lay people may not know the technical term to apply to people who are manifestly out of touch with reality, but they will readily recognize this unfortunate condition. No further tests of any sort will be necessary to prove that

21. For an amusing exception, see Craig M. Bennett et al., *Neural Correlates of Interspecies Perspective Taking in the Post-Mortem Atlantic Salmon: An Argument for Multiple Comparisons Correction*, 1 J. SERENDIPITOUS & UNEXPECTED RESULTS 1 (2009), available at <http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.161.83>

84&rep=rep1&type=pdf (The study scanned a dead Atlantic salmon to demonstrate that significant results can be obtained from the most unpromising investigation unless the research design properly controls for chance findings [false positives]).

the subject suffers from seriously impaired rationality. In such cases, neuroevidence will be at most convergent and increase our confidence in what we already had confidently concluded. Determining if it is worth collecting the neuroevidence will depend on whether the cost-benefit analysis justifies obtaining convergent evidence.

Roper v. Simmons is the most striking example of a case in which the behavioral evidence was clear.²² In *Roper* the United States Supreme Court categorically excluded the death penalty for capital murderers who killed when they were 16 or 17 years old on the grounds that adolescents do not deserve the death penalty.²³ The amicus briefs were replete with neuroscience data showing that the brains of late adolescents are not fully biologically mature, and advocates used this data to suggest that adolescent killers could not be fairly put to death.²⁴ Now, we already knew from common sense observation and from rigorous behavioral studies that juveniles are on average less rational than adults. What did the neuroscientific evidence about the juvenile brain add? It was consistent with the undeniable behavioral data and perhaps provided a partial causal explanation of the behavioral differences. The neuroscience data was therefore merely additive and only indirectly relevant, and the Supreme Court did not cite it, except perhaps by implication when it referred vaguely to “other” scientific evidence.²⁵

Whether adolescents are sufficiently less rational on average than adults to exclude them categorically from the death penalty is of course a normative legal question and not a scientific or psychological question. Advocates claimed, however, that the neuroscience confirmed that adolescents are insufficiently responsible to be executed,²⁶ thus confusing the positive and the normative. The neuroscience evidence in no way independently confirms that adolescents are less responsible. If the behavioral differences between adolescents and adults were slight, it would not matter if their brains were quite different. Similarly, if the behavioral differences were sufficient for moral and constitutional differential treatment, then it would not matter if the brains were essentially indistinguishable.

If the behavioral data are not clear, then the potential contribution of neuroscience is large. Unfortunately, it is in just such cases that neuroscience, at present, is not likely to be of much help. I term the reason for this the “clear-cut” problem.²⁷ Recall that neuroscientific studies usually start with clear cases of well-characterized behavior. In such cases, the neural markers might be quite sensitive to the already clearly identified behaviors precisely because the behavior is so clear. Less clear behavior is simply not studied, or the overlap in data about less

clear behavior is greater between experimental and control subjects. Thus, the neural markers of clear cases will provide little guidance to resolve behaviorally ambiguous cases of legally relevant behavior, and they are unnecessary if the behavior is sufficiently clear.

For example, suppose that in an insanity defense case the question is whether the defendant suffers from a major mental disorder, such as schizophrenia. In extreme cases, the behavior will be clear, and no neurodata will be necessary. Investigators have discovered various small but statistically significant differences in neural structure or function between people who are clearly suffering from schizophrenia and those who are not.²⁸ Nonetheless, in a behaviorally unclear case, the overlap between data on the brains of people with schizophrenia and people without the disorder is so great that a scan is insufficiently sensitive to be used for diagnostic purposes. In short, at present, in those cases in which the neuroscience would be most helpful, it has little to contribute. Again, this situation may change if neural markers become more diagnostically sensitive for legally relevant criteria.

Some people think that executive capacity—the congeries of cognitive and emotional capacities that help to plan and regulate human behavior—is going to be the Holy Grail that helps the law determine an offender’s true culpability. After all, there is an attractive moral case that people with a substantial lack of these capacities are less culpable, even if their conduct satisfied the *prima facie* case for the crime charged. Perhaps neuroscience can provide specific data previously unavailable to identify executive capacity differences more precisely.

There are two problems, however. First, significant problems with executive capacity are readily apparent without testing, and criminal law simply will not adopt fine-grained culpability criteria. Second, the correlation between neuropsychological tests of executive capacity and actual real world behavior is not terribly strong.²⁹ Only a small fraction of the variance is accounted for, and the scanning studies will use the types of tasks the tests use. Consequently, we are far from able to use neuroscience accurately to assess non-obvious executive capacity differences that are valid in real world contexts.

“The neuroscience evidence in no way independently confirms that adolescents are less responsible.”

22. 543 U.S. 551 (2005).

23. *Id.* at 578–79.

24. *Id.* at 569.

25. *Id.* at 569, 573. The Supreme Court referred generally to other science, but it was not clear whether neuroscience played a specific role. The Supreme Court did cite neuroscientific findings in *Graham v. Florida*, 130 S. Ct. 2011 (2010), which categorically excluded juveniles from life without the possibility of parole in non-homicide cases. *Id.* at 2034. The citation was general, and I believe it was dictum. The Supreme Court was responding to an argument that no party had seriously made, which was that the

science of adolescent development had changed significantly since *Roper* was decided. *Id.* at 2026–27.

26. *Roper*, 543 U.S. at 569.

27. Morse, *supra* note 17, at 540.

28. On the other hand, there may be reason to be cautious about such findings. See generally Ioannidis, *supra* note 19.

29. See, e.g., Russell A. Barkley & Kevin R. Murphy, *Impairment in Occupational Functioning and Adult ADHD: The Predictive Utility of Executive Function (EF) Ratings versus EF Tests*, 25 ARCHIVES CLINICAL NEUROPSYCHOLOGY 157 (2010).

“[N]euroscience may make a positive contribution [to the law] even though there has been no [change] in thinking about the nature of the person and the criteria for criminal responsibility.”

THE RADICAL NEURO-CHALLENGE: ARE WE VICTIMS OF NEURONAL CIRCUMSTANCES?

This part addresses the claim and hope alluded to earlier that neuroscience will cause a paradigm shift in criminal responsibility by demonstrating that we are merely victims of neuronal circumstances (or some similar claim that denies human agency). This claim holds that we are not the kinds of intentional creatures we think we are. If our mental states play

no role in our behavior and are simply epiphenomenal, then traditional notions of responsibility based on mental states and on actions guided by mental states would be imperiled. But is the rich explanatory apparatus of intentionality simply a post hoc rationalization that the brains of hapless homo sapiens construct to explain what their brains have already done? Will the criminal justice system as we know it wither away as an outmoded relic of a prescientific and cruel age? If so, criminal law is not the only area of law in peril. What will be the fate of contracts, for example, when a biological machine that was formerly called a person claims that it should not be bound because it did not make a contract? The contract is also simply the outcome of various “neuronal circumstances.”

Given how little we know about the brain-mind and brain-action connections, to claim that we should radically change our conceptions of ourselves and our legal doctrines and practices based on neuroscience is a form of neuroarrogance. Although I predict that we will see far more numerous attempts to introduce neuroevidence in the future, I have elsewhere argued that for conceptual and scientific reasons, there is no reason at present to believe that we are not agents.³⁰ It is possible that we are not agents, but the current science does not remotely demonstrate that this is true. The burden of persuasion is firmly on the proponents of the radical view.

What is more, the radical view entails no positive agenda. Suppose we are convinced by the mechanistic view that we are not intentional, rational agents after all.³¹ What should we do now? We know that it is an illusion to think that our deliberations and intentions have any causal efficacy in the world. We also know, however, that we experience sensations—such as pleasure and pain—and care about what happens to us and to the world. We cannot just sit quietly and wait for our brains to activate, for determinism to happen. We must and will deliberate and act.

Even if we thought that the radical view was correct and standard notions of genuine moral responsibility and desert were therefore impossible, we might still believe that the law would not necessarily have to give up the concept of incentives. Indeed, Greene and Cohen concede that we would have to keep punishing people for practical purposes.³² Such an account would be consistent with “black box” accounts of economic incentives that simply depend on the relation between inputs and outputs without considering the mind as a mediator between the two. For those who believe that a thoroughly naturalized account of human behavior entails complete consequentialism, this conclusion might be welcomed.

On the other hand, this view seems to entail the same internal contradiction just explored. What is the nature of the agent that is discovering the laws governing how incentives shape behavior? Could understanding and providing incentives via social norms and legal rules simply be epiphenomenal interpretations of what the brain has already done? How do we decide which behaviors to reward or punish? What role does reason—a property of thoughts and agents, not a property of brains—play in this decision?

If the truth of pure mechanism is a premise in deciding what to do, no particular moral, legal, or political conclusions follow from it.³³ The radical view provides no guide as to how one should live or how one should respond to the truth of reductive mechanism. Normativity depends on reason and, thus, the radical view is normatively inert. If reasons do not matter, then we have no reason to adopt any particular morals, politics or legal rules, or to do anything at all.

Given what we know and have reason to do, the allegedly disappearing person remains fully visible and necessarily continues to act for good reasons, including the reasons currently to reject the radical view. We are not Pinocchios, and our brains are not Geppettos pulling the strings.

THE CASE FOR CAUTIOUS NEUROLAW OPTIMISM

Despite having claimed that we should be exceptionally cautious about the current contributions that neuroscience can make to criminal law policy, doctrine, and adjudication, I am modestly optimistic about the near and intermediate term contributions neuroscience can potentially make to our ordinary, traditional, folk-psychological legal system. In other words, neuroscience may make a positive contribution even though there has been no paradigm shift in thinking about the nature of the person and the criteria for criminal responsibility. The legal regime to which neuroscience will contribute will continue to take people seriously as people—as autonomous agents who may fairly be blamed and punished based on their mental states and actions.

In general, the hope is that over time there will be feedback between the folk-psychological criteria and the neuroscientific

mechanism is simply neurophysically transformed.

32. Greene & Cohen, *supra* note 7, at 218.

33. This line of thought was first suggested by Professor Mitchell Berman in the context of a discussion of determinism and normativity. Mitchell Berman, *Punishment and Justification*, 118 *ETHICS* 258, 271 (2008).

30. Morse, *supra* note 17, at 543–54; Stephen J. Morse, *Determinism and the Death of Folk Psychology*, 9 *MINN. J. L., SCI. & TECH.* 1 (2008).

31. Of course, the notion of being “convinced” would be an illusion, too. Being convinced means that we are persuaded by evidence or argument, but a mechanism is not persuaded by anything. A

data. Each might inform the other. Conceptual work on mental states might suggest new neuroscientific studies, for example, and the neuroscientific studies might help refine the folk-psychological categories. The ultimate goal would be a reflective, conceptual-empirical equilibrium.

More specifically, there are four types of situations in which neuroscience may be of assistance: (a) data indicating that the folk-psychological assumption underlying a legal rule is incorrect; (b) data suggesting the need for new or reformed legal doctrine; (c) evidence that helps adjudicate an individual case; and (d) data that help efficient adjudication or administration of criminal justice.

Many criminal law doctrines are based on folk-psychological assumptions about behavior that may prove to be incorrect. If so, the doctrine should change. For example, it is commonly assumed that agents intend the natural and probable consequences of their actions. In many or most cases it seems that they do, but neuroscience may help in the future to demonstrate that this assumption is true far less frequently than we think. In that case, the rebuttable presumption used to help the prosecution prove intent should be softened or used with more caution.

Second, neuroscientific data may suggest the need for new or reformed legal doctrine. For example, control tests for legal insanity have been disfavored for some decades because they are ill understood and hard to assess. It is at present impossible to distinguish “cannot” from “will not.” Perhaps neuroscientific information will help to demonstrate and to prove the existence of control difficulties that are independent of cognitive incapacities. If so, then perhaps control tests are justified and can be rationally assessed after all. More generally, perhaps a larger percentage of offenders than we currently believe have such grave control difficulties that they deserve a generic mitigation claim that is not available in criminal law today. Neuroscience might help us discover that fact. If that were true, justice would be served by adopting a generic mitigating doctrine. On the other hand, if it turns out that such difficulties are not so common, we could be more confident of the justice of current doctrine.

Third, neuroscience might provide data to help adjudicate individual cases. Consider the insanity defense again. As in *United States v. Hinckley*,³⁴ there is often dispute about whether a defendant claiming legal insanity suffered from a mental disorder, which disorder the defendant suffered from, and how severe the disorder was.³⁵ At present, these questions must be resolved entirely behaviorally, and there is often room for considerable disagreement about inferences drawn from the defendant’s actions, including utterances. In the future, neuroscience might help resolve such questions if the clear-cut-problem difficulty can be solved. As mentioned previously, however, in the foreseeable future, I doubt that neuroscience will be able to help identify the presence or absence of specific *mentes reae*.

Finally, neuroscience might help us to implement current

policy more efficiently. For example, the criminal justice system makes predictions about future dangerous behavior for purposes of bail, sentencing (including capital sentencing), and parole. If we have already decided that it is justified to use dangerousness predictions to make such decisions, it is hard to imagine a rational argument for doing it less accurately if we are in fact able to do it more accurately. Behavioral prediction techniques already exist. The question is whether neuroscientific variables can add value by increasing the accuracy of such predictions considering the cost of gathering such data. It is perfectly plausible that in the future they may do so, and thus, decisions will be more accurate and just.³⁶

CONCLUSION

At present, neuroscience has little to contribute to more just and accurate criminal law decision making concerning policy, doctrine and individual case adjudication. This was the conclusion reached when I tentatively identified “brain overclaim syndrome” five years ago, and it remains true today. In the future, however, as neuroscience and the philosophies of mind and action mutually mature and inform one another, neuroscience will help us understand criminal behavior. Although no radical transformation of criminal justice is likely to occur, neuroscience can inform criminal justice as long as it is relevant to law and translated into the law’s folk-psychological framework and criteria.



Stephen J. Morse, J.D., Ph.D. is Ferdinand Wakeman Hubbell Professor of Law; Professor of Psychology and Law in Psychiatry at the University of Pennsylvania. He is an expert in criminal and mental health law, whose work emphasizes the relation of the sciences to responsibility and social control. Dr. Morse has published *A Primer on Criminal Law and*

Neuroscience (Oxford University Press, with Adina L. Roskies), *Foundations of Criminal Law* (Foundation Press, with Leo Katz and Michael S. Moore), *Crime and Culpability: A Theory of Criminal Law* (Cambridge University Press, with Larry Alexander and Kimberly Ferzan), and he is currently working on a book, *Desert and Disease: Responsibility and Social Control*. Professor Morse was Co-Director of the MacArthur Foundation Law and Neuroscience Project and is a member of the MacArthur Foundation Research Network on Law and Neuroscience. He also is the founding director of the Neuroethics Society and a trustee of the Bazelon Center for Mental Health Law in Washington, D.C. (1995-present). He received the American Academy of Forensic Psychology’s Distinguished Contribution Award and the American Psychiatric Association’s Isaac Ray Award for distinguished contributions to forensic psychiatry.

34. 525 F. Supp. 1342 (D.D.C. 1981).

35. *Id.* at 1346.

36. Eyal Aharoni et al., *Neuroprediction of Future Arrest*, 110 PNAS

6223 (2013); Dustin A. Pardini et al., *Lower Amygdala Volume in Men Is Associated with Childhood Aggression, Early Psychopathic Traits, and Future Violence*, 75 BIOLOGICAL PSYCHIATRY 73 (2014).

Keeping Up with Neurolaw: What to Know and Where to Look

Francis X. Shen

It is hard to know exactly what the future holds for law and neuroscience. But it is a fair bet that the future will look different, perhaps markedly so, than the neurolaw of today. How can one keep up with this change? In this brief essay, I provide a series of resources for those interested in expanding their knowledge of fundamental law and neuroscience issues, as well as keeping up to date on cutting-edge innovations.

A useful starting point for orienting to neurolaw is Bill Gates's observation on technological change, "People often overestimate what will happen in the next two years and underestimate what will happen in ten."¹ Gates suggests the importance of both a short-term and long-term view. In the short-term, it seems unlikely that legislators, advocates, or judges will produce a paradigm shift in law, or that any single neuroscience discovery will be game changing. In the long-term, however, the possibilities (as discussed by the many commentaries in this issue) are numerous and potent. The informed consumer and producer of neurolaw should be sensitive to both of these time horizons.

The practical reality of legal and judicial practice is that knowledge is typically and rightly driven by case-specific needs. The resources that follow provide general orientation, allowing navigation toward more specific information of great relevance for a specific case or query.

PUBLISHED RESOURCES FOR THE REFERENCE SHELF

With a Law and Neuroscience Bibliography that now includes more than 1,000 entries, there is no lack of reading material in neurolaw. The bibliography is online, sortable, and searchable at www.lawneuro.org/bibliography.php. There are many specific topics covered in the bibliography, and general references include:

- OWEN D. JONES, JEFFREY D. SCHALL & FRANCIS X. SHEN, *LAW AND NEUROSCIENCE* (2014). This is the first coursebook in law and neuroscience, and it provides over 800 pages of hard copy in 21 chapters, with additional online materials and over 1,000 links. It is the single largest compendium of neurolaw materials. An overview, and sample chapter, are available online at <http://www.vanderbilt.edu/lawbrain>.
- Henry Greely & Anthony Wagner, Reference Guide on Neuroscience, in *FEDERAL JUDICIAL COLLEGE REFERENCE MANUAL ON SCIENTIFIC EVIDENCE* (3d ed. 2012).² This chapter by Greely and Wagner is an excellent, concise introduction to the field.
- A PRIMER ON CRIMINAL LAW AND NEUROSCIENCE (Stephen J. Morse & Adina L. Roskies eds., 2013). This edited volume

presents an all-star roster of scientists and legal thinkers on core issues in criminal law and cognitive neuroscience.

- Owen D. Jones, Joshua W. Buckholtz, Jeffrey D. Schall & René Marois, *Brain Imaging for Legal Thinkers: A Guide for the Perplexed*, 2009 *STAN. TECH. L. REV.* 5 (2009). This is a great introduction for the legal community to neuroimaging generally, and fMRI specifically.
- *OXFORD HANDBOOK OF NEUROETHICS* (Judy Illes & Barbara J. Sahakian eds., 2011). Neuroethics considers the ethical implications of neuroscience, including a number of issues germane to law and policy. This Handbook is a wonderful and comprehensive collection of contemporary neuroethics thought. You might also check out the journal *Neuroethics*, which often publishes work relevant to law.

ONLINE RESOURCES. The easiest way to keep up to date on neurolaw is to visit regularly or subscribe to updates from websites dedicated to law and neuroscience. These sites include the following:

- www.lawneuro.org, hosted by *The MacArthur Foundation Research Network on Law and Neuroscience*, provides excellent introductory materials on neurolaw, links to conferences, a bibliography, and a blog with notable news from around the neurolaw universe. On the site you can subscribe to *Neurolaw News* at lawneuro.org/listserv.php. *Neurolaw News* is a free service devoted to regularly circulating news of developments in scholarship, courts, and conferences in the field of neurolaw.
- kolber.typepad.com is the *Neuroethics & Law Blog*, maintained by law professor Adam Kolber. It features weekly dispatches from the Johns Hopkins Program in Ethics and Brain Sciences and guest bloggers on relevant neurolaw topics.
- neuroethics.upenn.edu, hosted by the University of Pennsylvania's Center for Neuroethics & Society, announces neurolaw events, highlights news of interest, and promotes awareness of neuroscience in society.
- clbb.mgh.harvard.edu, the home of the Massachusetts General Hospital Center for Law, Brain & Behavior, features news, events, and commentary on neuroscience and law.
- www.ssrn.com/link/Law-Neuroscience.html links to the *Law and Neuroscience eJournal*, featuring recent neurolaw works uploaded to the Social Science Research Network (SSRN).
- dana.org features the work of the Dana Foundation, which supports and disseminates research on the brain and the implications of brain research for society and law.

Footnotes

1. BILL GATES, *THE ROAD AHEAD* 316 (1996).

2. Available online at http://www.nap.edu/openbook.php?record_id=13163&page=747.

USER-FRIENDLY SCIENCE UPDATES. Every week hundreds of research findings are published, posted, and circulated in neuroscience communities.³ Most of these studies will not, and are not designed to, have direct bearing on law. But a few might. To keep an eye on what's happening, the following sites provide user-friendly summaries and critiques of notable studies:

- www.sciencedaily.com/news/mind_brain/neuroscience/ ScienceDaily provides an excellent compendium of recent psychology and neuroscience research, each summarized in press-release-style posts.
- blogs.discovermagazine.com/neuroskeptic/ Neuroskeptic is a useful resource for providing a critical eye on recent neuroscience research. The conversation in blog comments is often just as interesting as the posts themselves.
- mindhacks.com/ MindHacks describes itself as providing "Neuroscience and psychology tricks to find out what's going on inside your brain." It is consistently entertaining and often has legal relevance.

LEARNING ABOUT THE BRAIN (IF LIFE IS BUSY). A daunting task for wading into the neurolaw waters is the lack of scientific training that typically accompanies legal education. Where should the lawyer or jurist begin to catch up? The printed materials referenced earlier are all helpful, as the *Law and Neuroscience* coursebook includes a very user-friendly module on "The Fundamentals of Cognitive Neuroscience." It covers brain structures, brain function, and methods for studying (and imaging) the brain. In addition, the *Research Network on Law and Neuroscience* provides a variety of links to recommended neuroscience texts at <http://www.lawneuro.org/resources.php>.

Online, I suggest two additional resources. The first comes from the *Society for Neuroscience* (SfN, <http://www.sfn.org/>), which is the nation's hub for the neuroscience community. SfN produces the site www.brainfacts.org, which is specifically designed for a general audience. On the *Brain Facts* site, you can catch up on brain basics, learn how to spot neuromyths, and read engaging stories about new research. Another fantastic resource is Neuroscientist Eric Chudler's *Neuroscience for Kids* site: <http://faculty.washington.edu/chudler/neurok.html>. Here's a tip: it's not just for kids. Dr. Chudler's award-winning site will answer many of those "I should really know the answer to this, but I don't . . ." questions. It is written in clear prose with useful illustrations.

LEARNING ABOUT THE BRAIN (IF YOU HAVE MORE TIME). While the above-mentioned websites may be more than enough for the time-constrained consumer of neurolaw, there are some additional options available if one has more

time to invest. Online, you can take advantage of the proliferation of free online courses and videos. For instance, through the Massachusetts Institute of Technology (MIT)'s OpenCourseWare project, you can take (via online lecture and accompanying reading materials) virtually all of the core offerings in their Brain and Cognitive Sciences catalog: <http://ocw.mit.edu/courses/brain-and-cognitive-sciences>.

If you prefer in-person instruction, be on the lookout for educational opportunities for the legal community. For instance, the Education and Outreach program (which I direct) of the MacArthur Foundation Research Network on Law and Neuroscience has developed a curriculum to introduce neuroscience in legally relevant ways to judges and lawyers. Videos and briefing materials from past programs are available in the Education and Outreach section of the Network's website (www.lawneuro.org), and you can be notified of future such programs by subscribing to the Network's email listserv (*Neurolaw News*, mentioned above). In addition to the Research Network, other sponsoring organizations have included the American Association for the Advancement of Science, the Gruter Institute for Law and Behavioral Research, the Federal Judicial Center, the National Judicial College, and the Advanced Science & Technology Adjudication Resource Center (ASTAR). Most of these programs run a day or two and provide an overview of key topics in neurolaw.

Finally, if you have ten days over the summer, you might consider applying to the University of Pennsylvania's Neuroscience Boot Camp. The Boot Camp is run by UPenn's Center for Neuroscience and Society and "is designed to give participants a basic foundation in cognitive and affective neuroscience and to equip them to be informed consumers of neuroscience research."⁴ As a Boot Camp alumnus, I can report with firsthand knowledge that the program is exceptional.

THE FUTURE OF NEUROLAW. Writing about the history of artificial intelligence, Ray Kurzweil stated:

The technology "hype cycle" for a paradigm shift . . . typically starts with a period of unrealistic expectations based on a lack of understanding of all the enabling factors required. . . . While the widespread expectations for revolutionary change are accurate, they are incorrectly timed. When the prospects do not quickly pan out, a period of disillusionment sets in. Nevertheless exponential growth continues unabated and years later a more mature and realistic transformation does take place.

It may well be that law and neuroscience will enter a period, or perhaps we're already there, of disillusionment. For

3. Leading general scientific journals *Science* and *Nature* typically publish a couple of neuroscience papers each issue as well as frequent news and commentaries relevant to the law. Within the neuroscience community, journals of note that publish original research findings include *Journal of Neuroscience*, *Nature Neuroscience*, and *Neuron*. You can also gain more general knowledge

from highly qualified reviews published in the *Annual Review of Neuroscience*, *Current Opinion in Neurobiology*, *Nature Reviews Neuroscience*, *Trends in Cognitive Sciences*, and *Trends in Neuroscience*.

4. <http://neuroethics.upenn.edu/index.php/events/neuroscience-bootcamp>

instance, the *New York Times* ran an op-ed in 2012 called “Neuroscience: Under Attack”; a scholar recently wrote an article called “The Problem with Neurolaw”; and 2013 saw the publication of *Brainwashed: The Seductive Appeal of Mindless Neuroscience*. Critiques such as these can be helpful in that they remind us to be cautious. This is appropriate for the short term.

But we should be cautious with our caution. Today’s best medicine can’t tell us definitively if or when we’ll have cancer; today’s best meteorology can’t tell us when exactly we’ll have another hurricane; and today’s best paleontologists still can’t tell us exactly what T. rex was doing all day. But we don’t distrust the endeavors of these fields, and we are patient with their progress.

The same can be said for neuroscience generally, and for neuroscience and law in particular. Neuroscience can’t do a lot of things right now (for law or for medicine) that we’d like it to do. But there’s good reason to think that just as medical treatments for neurological and psychological disorders are improving, in the future neuroscience will excite, challenge, and frustrate the legal system in new ways.

If so, the legal system of tomorrow will rely on those visionary judges, lawyers, and citizens who have been keeping up with neurolaw.



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The Resource Page



WEBSITES OF INTEREST

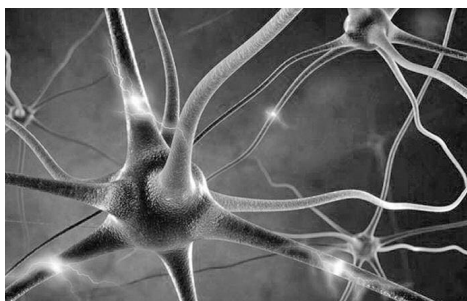
The MacArthur Foundation Research Network on Law and Neuroscience

<http://www.lawneuro.org>

Judges will find a wealth of resources at the website of the MacArthur Foundation Research Network on Law and Neuroscience. In 2007, the John D. and Catherine T. MacArthur Foundation initially funded an interdisciplinary research effort to integrate law and neuroscience. Since 2010, Vanderbilt University law professor Owen Jones has been the Network's director.

In its initial phases, between 2007 and 2011, the Network "pursued several over-arching research questions at the intersection of neuroscience and law that were intended to:

- Improve legal decisions about the responsibility of transgressors for their actions;
- Further identify factors that can affect blameworthiness assessments;
- Illuminate the processes by which jurors and judges make decisions about criminal liability and punishment;
- Enable more reliable identification of deceptive testimony;
- Increase law's abilities to evaluate the reliability of memories on which testimony is based;
- Aid law's abilities to predict recidivism and future dangerousness;
- Assess distinctions between neuroscientific evidence that should and should not be admitted in various criminal law contexts; and
- Aid the proper interpretation, by jurors and judges, of neuroscientific evidence."



The Network also convened seven major conferences for judges as well as 15 smaller, judge-focused conferences hosted by the Gruter Institute for Law and Behavioral Research in partnership with a variety of state judicial organizations, including the California Judges Association, introducing law and neuroscience techniques and issues to nearly 800 judges.

Today, the Network "addresses a focused set of closely-related problems at the intersection of neuroscience and criminal justice: (1) investigating law-relevant mental states of, and decision-making processes in, defendants, witnesses, jurors, and judges; (2) investigating in adolescents the

relationship between brain development and cognitive capacities; and (3) assessing how best to draw inferences about individuals from group-based neuroscientific data." It focuses on five legal problems, ranging from "challenges for law of ascertaining mental states of defendants and witnesses[, to] empirical . . . questions of a defendant's mental and behavioral capacities[, to] the difficulties that neuroscientific evidence poses for judges making evidentiary decisions."

On the website, you'll find a comprehensive law and neuroscience bibliography, and there's also a tab you can choose on the website home page from which you can request suggestions for a speaker on a law-and-neuroscience topic for a judicial conference or other gathering. Also, you can subscribe to *NeuroLaw News* at lawneuro.org/listserv.php.

Court Review was pleased to have the support of the Network in putting together this special issue. Several of the authors of articles in this issue also serve as members of the Network.



SPEAKERS

JUDICIAL AMBASSADORS: An Outreach Program of the American Psychological Association's Committee on Legal Issues

<http://www.goo.gl/OpAZyE>

As part of an ongoing effort to build and maintain effective relationships between the psychological and judicial communities, the American Psychological Association (APA) Committee on Legal Issues maintains an outreach program called Judicial Ambassadors. The Judicial Ambassadors program seeks to bring psychologists and court professionals together in a variety of contexts to facilitate the following goals:

- To make psychological research more accessible to and useful for courts and judges;
- To work with court officials to develop collaborative research and continuing education programs;
- To increase psychologists' understanding of court operations and legal practice;
- To improve psychological research about legal issues; and
- To facilitate courts' ability to apply psychological theories and models in court-related research.

Judicial Ambassadors are drawn from APA's membership (which includes more than 125,000 psychologists) based on their scientific expertise in the subjects of interest to the court. The Judicial Ambassadors program also has funding to help make experts available to interested judicial organizations for a variety of purposes, including designing and implementing educational programs and workshops, assisting courts with technical projects or program evaluations, and participating in advisory committees.

For more information about the Judicial Ambassadors Program, you can contact Donna Beavers, Office of General Counsel, American Psychological Association, 750 First Street, NE, Washington, DC 20002, email: dbeavers@apa.org.