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Who Speaks for Neuroscience? Neuroimaging Evidence and Courtroom Expertise

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"[T]hose witnesses who succeed in the marketplace for experts within our adversarial process will often not be those with the most knowledge or actual expertise in a particular area, but rather those whom parties believe will succeed in persuading the factfinder."[1]

Preface

Professor Paul Giannelli is a leader in the scholarly field of expert testimony, inspiring and educating generations of judges, litigants, students, and fellow academics about the intersection of science and law and the role of expert witnesses.[2] A pioneer in this interdisciplinary area, he has maintained an abiding focus on the importance of accuracy in scientific evidence and evinced an equally strong commitment to justice in criminal prosecutions. To those ends, Professor Giannelli has written about the unfairness of criminal defendants shouldering the burden of proof to establish the unreliability of expert testimony,[3] the need for independent crime labs to resolve the

† Carol Los Mansmann Chair in Faculty Scholarship and Professor, Duquesne University School of Law. The title for this article was inspired by Simon A. Cole's excellent article, *Who Speaks for Science? A Response to the National Academy of Science's Report on Forensic Science*, 9 J.L., Prob., & Risk, 25 (2009). While the phrase "who speaks for science" has roots old and deep, Professor Cole's article is an important comment on the relationship of science and law. Professor Moriarty thanks former and current law students Emily Bittle, Kristin Hravnak, and Richard Bielawa, for their research assistance.

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1. Jennifer L. Mnookin, *Expert Evidence, Partisanship, and Epistemic Competence*, 73 Brook. L. Rev. 1009, 1011 (2008).

2. *See* Paul C. Giannelli et al., Scientific Evidence (5th ed. 2013). The first edition of this treatise was published in 1986.

3. *See* Paul C. Giannelli, *The Admissibility of Novel Scientific Evidence:* Frye v. United States*, a Half-Century Later*, 80 Colum. L. Rev. 1197, 1248 (1980) (arguing that the "prosecution in a criminal case should be required to establish the validity of a novel scientific technique beyond a reasonable doubt" before it is admissible evidence but that in civil cases, by

problem of "pro-prosecution" experts,[4] the right of indigent defendants to have competent expert assistance,[5] the perennial problem of junk science in criminal cases,[6] and the relationship of legal ethics and expert witnesses.[7] He has also been a good friend and wonderful collaborator with one of the authors of this Article.[8] This Article is in his honor.

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INTRODUCTION

This Article explores the issue of proper qualifications necessary for expert witnesses who testify about structural and functional neuroimaging evidence. It outlines the nature of the problem; explains some of the complexity of the question of expertise as a matter of medicine,

comparison, the proponent should only need to prove its validity by a preponderance of the evidence).

4. *See* Paul C. Giannelli, *The Abuse of Scientific Evidence in Criminal Cases: The Need for Independent Crime Laboratories*, 4 VA. J. SOC. POL'Y & L. 439, 441 (1997) (noting that "[t]oo many experts in the criminal justice system manifest a police-prosecution bias, a willingness to shade or distort opinions to support the state's case"); Paul C. Giannelli, Daubert *and Forensic Science: The Pitfalls of Law Enforcement Control of Scientific Research*, 2011 U. ILL. L. REV. 53 (arguing in favor of an independent agency for forensic science).

5. *See* Paul C. Giannelli, Ake v. Oklahoma*: The Right to Expert Assistance in a Post-*Daubert*, Post-DNA World*, 89 CORNELL L. REV. 1305 (2004) (discussing the need for expert witnesses, given the widespread use of prosecution experts, the increase in types of experts uses, and the problems of fraud and error in laboratories).

6. *See* Paul C. Giannelli, *"Junk Science": The Criminal Cases*, 84 J. CRIM. L. & CRIMINOLOGY 105 (1993); Paul C. Giannelli, *Junk Science and the Execution of an Innocent Man*, 7 N.Y.U. J.L. & LIBERTY 221 (2013).

7. *See* Paul C. Giannelli & Kevin C. McMunigal, *Prosecutors, Ethics, and Expert Witnesses,* 76 FORDHAM L. REV. 1493 (2007).

8. Jane Moriarty is a contributing author to the Fifth Edition of *Scientific Evidence*. GIANNELLI ET AL., *supra* note 2.

science, and law, using criminal cases involving mental health as a helpful template to discuss the issues; provides some thoughts about better regulating neuroimaging evidence by focusing on the qualifications of experts; and offers modest policy suggestions to address the question of expert competence.

I. Neuroscience, Neuroimaging, and Categorical Questions About Expertise

Lawyers, judges, legal academics, and the media often use the term "neuroscience" in a general manner to describe a wide variety of evidence or information concerning medicine, psychology, and various disciplines related to the human brain, thought, and behavior.[9] Scientists, however, employ a more precise definition of "neuroscience" as the scientific study of the nervous system.[10] The study of neuroscience is remarkably broad, examining many species other than just humans, and encompasses such diverse fields as experimental neurobiology, cognitive science, and medicine.[11] The goals and methods of the various neuroscience subspecialties differ widely. Those attempting to bring coherence to this transdisciplinary field note the problems of evaluating the epistemic value of the data, given the methodological, conceptual, and theoretical diversity within and between the multiple disciplines.[12] This multilayered complexity presents challenges for the scientific fields as well as for a legal system grappling with this developing field of science.

Much of the neuroscience information admitted in court is generated by structural and functional brain imaging, as explained below. Although neuroimaging scans are admitted into evidence in some cases, it is the interpretations of the scans that often provide the critical information, even when the scans themselves are excluded. To bring a bit more precision to the discussion, we will use the term "neuroimaging" throughout this article to describe the evidence that is often at issue in court.

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9. *See generally*, Owen D. Jones et al., Law and Neuroscience 9 (2014) (providing a useful guide for the legal audience under the heading "Navigating Neuroscience: Who Does What?").

10. Boris Kotchoubey et al., *Methodological Problems on the Way to Integrative Human Neuroscience*, Frontiers in Integrative Neurosci., Nov. 2016, at 1, 2 (quoting *About JNeurosci*, JNeurosci, http://www.jneurosci.org/content/about-jneurosci [https://perma.cc/D84G-TM2L] (last visited Mar. 2, 2018)).

11. *Id.* at 4.

12. *Id.* at 2.

One important distinction among numerous techniques used to image the nervous system is between "structural" and "functional" imaging. The former is focused on imaging the anatomical structures and changes that are irreversible or are slow relative to the typical human-behavioral changes. The latter is focused on transient and reversible changes in the nervous system concurrent with behavior, such as changes in blood flow or metabolism while pressing a button or attending to pictures on a screen. Common examples of structural imaging are X-rays, some forms of Computerized Tomography ("CT") scans, and Magnetic Resonance Imaging ("MRI"). Functional neuroimaging is represented by Positron Emission Tomography ("PET"), Single Photon Emission Computed Tomography ("SPECT"), and functional MRI ("fMRI").[13] While fMRI has little forensic application to date, PET, CT, and MRI have been regularly admitted and collectively constitute nearly two-thirds of the admitted neuroimaging evidence in criminal cases.[14]

Contemporary neuroimaging research is multidisciplinary, with various experts contributing to an aspect of the design, implementation, and interpretation of data. Similarly, medical treatment that relies on neuroimaging for diagnosis and monitoring generally involves a team approach in which various specialized physicians and non-physicians collaborate to order, perform, interpret, and apply the results of neuroimaging studies, as might occur in head injury or stroke.

This interplay of specialties presents challenging questions about how to determine the proper qualifications for witnesses who may testify about the various aspects of neuroimaging evidence. The growth of neuroimaging as both an area of basic research and as a branch of clinical diagnostic radiology has blurred the lines between the practice of medicine and other areas of expertise. While a non-physician would not be permitted to order or interpret the results of neuroimaging studies in clinical practice, non-physician experts are asked to testify about the interpretation of CT, MRI, and PET scans in the courtroom.

MRI and fMRI contributed greatly to the growth on neuroscience research involving humans, referred to as cognitive, social, and

13. While Electroencephalography ("EEG") is categorized as a type of functional neuroimaging, we do not include it in our discussion here.

14. Nita A. Farahany, *Neuroscience and Behavioral Genetics in the US Criminal Law: An Empirical Analysis,* 2 J.L. & BIOSCIS. 485, 495 (2015). Professor Farahany's empirical study of neuroscience and behavioral genetics in criminal cases indicated PET scans were involved in 18 percent of cases, CT in 23 percent, and MRI in 24 percent. *Id.*

systems neuroscience.[15] Both types of MRI have spurred research in various forms of neuropathology such as traumatic, vascular, or degenerative brain injury that previously required more invasive and labor-intensive nuclear medicine techniques, such as PET or SPECT.

Blood Oxygenation Level Dependent ("BOLD") fMRI, which relies on endogenous changes in blood oxygenation rather than injections of contrast materials as a source of contrast, made fMRI safe to the point where it could be used in studies with risk-benefit ratio that would not justify using more invasive imaging techniques. Thus, BOLD fMRI was widely adopted to study basic cognitive processes, including behavioral regulation and impulsivity, and more complex social functions of morality, altruism, violence, and deception. This research, largely conducted by non-physicians, blurred the divide between medical research driven by clinical questions and basic science driven by the quest for knowledge.

Much neuroimaging research is funded by government organizations whose mission is to support science that has practical applications. As a result, neuroimaging researchers have been compelled to highlight the clinical relevance of even the most esoteric and cutting-edge research in papers and grants, despite the fact that clinical applications of fMRI remain few and far between.[16] Without question, this peer-reviewed work has significantly increased our insights into brain function and dysfunction.[17] However, the pressure for continuous innovation and often-times capricious patterns of biomedical research funding has had negative consequences as there is little confirmation of these insights by replication, meta-analyses, and large scale controlled clinical trials.[18]

Despite the volume of functional neuroimaging studies that are potentially relevant to the clinical practice of psychiatry, the

15. *See generally* Tatjana Aue et al., *Great Expectations: What Can fMRI Tell Us About Psychological Phenomena?*, 73 INT'L J. PSYCHOPHYSIOLOGY 10, 10 (2009); Peter A. Bandettini, *Twenty Years of Functional MRI: The Science and the Stories*, 62 NEUROIMAGE 575 (2012).

16. *See* S. Kapur et al., *Why Has it Taken So Long for Biological Psychiatry to Develop Clinical Tests and What to Do About It?*, 17 MOLECULAR PSYCHIATRY 1174, 1174 (2012).

17. *See generally* Nikos K. Logothetis, *What We Can and What We Cannot Do with fMRI*, 453 NATURE 869 (2008); Peter A. Bandettini, *What's New in Neuroimaging Methods*, 1156 ANN. N.Y. ACAD. OF SCI. 260 (2009).

18. *See e.g.*, John P.A. Ioannidis, *Why Most Published Research Findings Are False*, 2 PLOS MED. 124, 124 (2005); John P.A. Ioannidis, *Why Most Discovered True Associations Are Inflated*, 19 EPIDEMIOLOGY 640, 640 (2008); Henry T. Greely & Anthony D. Wagner, *Reference Guide on Neuroscience*, *in* REFERENCE MANUAL ON SCIENTIFIC EVIDENCE, 747, 776 (3d ed. 2011); Aue et al., *supra*, note 15, at 10.

uncontroversial applications of functional neuroimaging in clinical psychiatry are limited to the diagnosis of dementia[19] and pre-surgical mapping of the cerebral cortex. These areas are peripheral to psychiatry and are at its intersection with neurology and neurosurgery. According to the Consensus Report of the American Psychiatric Association Work Group on Neuroimaging Markers of Psychiatric Disorders in 2012, "[c]urrently neuroimaging is not recommended within either the U.S. or European practice guidelines for positively defining diagnosis of any primary psychiatric disorder."[20] This position is seconded by influential commentators.[21]

The ongoing NIH Research Domain Criteria Project ("RDCO") initiative aims to develop, for research purposes, "new ways of classifying mental illnesses—based on dimensions of observable behavior and neurobiological measures."[22] This effort ultimately may lead to a new clinical classification of mental disorders to match the new

19. *C.f.* Susan E. Rushing, Daniel A. Pryma and Daniel D. Langleben, *PET and SPECT*, in NEUROIMAGING IN FORENSIC PSYCHIATRY 4, 20 (Joseph R. Simpson ed., 2012) (noting that PET is "universally accepted" for diagnosing dementia and other degenerative brain diseases, and for strokes and malignancy).

20. MICHAEL FIRST ET AL., CONSENSUS REPORT OF THE APA WORK GROUP ON NEUROIMAGING MARKERS OF PSYCHIATRIC DISORDERS: RESOURCE DOCUMENT 2 (2012).

21. *See, e.g.,* James Giordano, *Neuoroimaging in Psychiatry: Approaching the Puzzle as a Piece of the Bigger Picture(s)*, AJOB NEUROSCI. Oct.–Dec. 2012, at 54 (2012); James A. Anderson & Judy Illes, *Neuroimaging and Mental Health: Drowning in a Sea of Acrimony*, AJOB NEUROSCI., Oct.–Dec. 2012, at 42 (2012); Martha J. Farah & Seth J. Gillihan, *The Puzzle of Neuroimaging and Psychiatric Diagnosis: Technology and Nosology in an Evolving Disipline*, AJOB NEUROSCI. Oct.–Dec. 2012, at 31 (2012); Jonathan B. Savitz et al., *Neuroimaging in Affective Disorders: Applications in Clinical Research and Forensic Psychiatry, in* NEUROIMAGING IN FORENSIC PSYCHIATRY 131 (Joseph R. Simpson, ed., 2012) (recognizing that neuroimaging data with mood disorders has been effectively applied to a class of individuals but the "the validity of applying neuroimaging technology to establish the presence of illness *in individual patients* remains problematic"); Argyris Stringaris, *Editorial: Neuroimaging in Clincal Psychiatry—When Will the Pay Off Begin?*, 56 J. CHILD PSYCHOL. & PSYCHIATRY 1263 (2015) (posing questions and providing answers about the lack of progress in neuroimaging to clinical utility); Faisal Akram & James Giordano, *Research Domain Criteria as Psychiatric Nosology: Conceptual, Practical and Neuroethical Implications*, 26 CLINICAL NEUROETHICS 592 (2017).

22. *NIMH Strategic Plan for Research: Highlight: What Is RCoC?*, NIMH, https://www.nimh.nih.gov/about/strategic-planning-reports/highlights/highlight-what-is-rdoc.shtml [https://perma.cc/WYA7-ES5S] (last visited Mar. 19, 2018).

neuroimaging research.[23] However, success of this initiative and subsequent translation into practice is far from guaranteed.[24] Much functional neuroimaging has great potential application for psychiatry and psychology and there are ongoing efforts to bridge the gap between the research and clinical practice.[25] This is a critically important next step but one that has not yet been taken.

A major concern for the clinical translation of neuroscience research, including functional neuroimaging, is the extrapolation of group average data from the laboratory to individual patients in the clinic.[26] Nonetheless, the obvious legal and social relevance of functional neuroimaging research has led some to make premature inferences and applications from these neuroimaging data to individuals in real-life settings without sufficient support.[27] And many courts have permitted such evidence to be admitted.

There are four categorical concerns that courts might consider in determining legal expertise relating to neuroimaging evidence involving behavioral science data. The first is the proper scope of medical expertise with respect to neuroimaging, which generally involves such specialties as neurology, radiology, neuroradiology, internal medicine, and psychiatry. As one commentator noted when discussing the complicated subspecialty boundaries of existing medicine, "[c]onsidering that neuroimaging technologies require specialized training in operation and interpretation, [and] assertions of expertise about the brain . . . questions arise as to who can speak authoritatively about

23. *NIMH Strategic Plan for Research: Objective 2*, NIMH, https://www.nimh.nih.gov/about/strategic-planning-reports/strategic-objective-2.shtml [https://perma.cc/P969-NNCV] (last visited Mar. 17, 2018).

24. *See generally* Kapur et al., *supra*, note 16.

25. Farah & Gillihan, *supra* note 21, at 31; Anderson & Illes, *supra*, note 21, at 42.

26. *See generally* GARY B. MELTON ET AL., PSYCHOLOGICAL EVALUATIONS FOR THE COURTS: A HANDBOOK FOR MENTAL HEALTH PROFESSIONALS AND LAWYERS (3d ed. 2007). For more on the concept of group-to-individual application from various disciplines to be used in court, see David L. Faigman et al., *Group to Individual (G2i) Inference in Scientific Expert Testimony*, 81 U. CHI. L. REV. 417 (2014).

27. C.C Meltzer et al., *Guidelines for the Ethical Use of Neuroimages in Medical Testimony: Report of a Multidisciplinary Consensus Conference*, 35 AM. J. OF NEURORADIOLOGY 632, 632 (2014); Rushing, Pyrma, & Langleben, *supra* note 19, at 22; JONES ET AL., *supra* note 9, at 17629; 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, 1199 (2010); Henry T. Greely & Judy Illes, *Neuroscience-Based Lie Detection: The Urgent Need for Regulation*, 33 AM. J.L. & MED. 377, 420 (2007).

the relationship between the brain and behavior . . . ."[28] While a neuroradiologist may be well qualified to testify about a neuroimaging study as a diagnostic tool for a neurodegenerative disease, she may be less qualified than a physician who treats patients with such disease to address the common behaviors associated with that disease process. Yet, both may have sufficient qualifications to serve as expert witnesses, given the breadth of a medical training.

The second concern is the comparative types of expertise among the non-medical professions who may testify about neuroimaging evidence in behavioral science cases. Those potential experts may include neuroscientists, clinical psychologists, neuropsychologists, research psychologists, and others, each of whom has a specific scope of expertise.

The third issue involving expertise depends upon whether the neuroimaging evidence is based on group data generally;[29] group data as applied to an individual;[30] or individual data applied either in a diagnostic fashion or to explain or excuse behavior.[31] While certain experts specializing in research may be qualified to testify about group data generally, those experts may not be qualified to testify about the diagnostic application of data to groups or more significantly, to individuals. Conversely, other experts, such as non-academic neuroradiologists, might be well-qualified to address diagnostic MRI

28. Neil K. Aggarwal, *Neuroimaging, Culture, and Forensic Psychiatry*, 37 J. AM ACAD. PSYCH. & L. 239, 241 (2009).

29. *See, e.g.*, Roper v. Simmons, 543 U.S. 551 (2005); Graham v. Florida, 560 U.S. 48 (2010); Miller v. Alabama, 567 U.S. 460 (2012). All three cases involved the use of neuroscience data in amicus briefs to support other scientific and psychological evidence submitted in the case indicating that adolescent minds differed from adult minds in multiple ways. *See, e.g.*, Brief for the American Psychological Association, American Psychiatric Association, and National Association of Social Workers as Amici Curiae in Support of Petitioners at 25–31, Miller v. Alabama, 567 U.S. 460 (2012) (Nos. 10-9646, 10-9647) (arguing that neuroscience suggests a possible physiological basis for fundamental differences between juvenile and adult minds). For more on the various roles of neuroscience experts in the legal system, see Owen D. Jones et al., *Neuroscientists in Court*, 14 NATURE REVS. NEUROSCI. 730 (2013).

30. *See generally* Faigman et al., *supra* note 26; Carl E. Fisher et al., *Toward a Jurisprudence of Psychiatric Evidence: Examining the Challenges of Reasoning from Group Data in Psychiatry to Individual Decisions in the Law*, 69 U. MIAMI L. REV. 685 (2015); *see also* Manish A. Fozdar, *The Relevance of Modern Neuroscience to Forensic Psychiatry Practice*, 44 J. AM. ACAD. PSYCHIATRY & L. 145, 147 (2013) (discussing the application of studies in a large group to a particular case).

31. Much neuroimaging sought to be used in court falls into this category. *See* Jane Campbell Moriarty et al., *Brain Trauma, PET Scans and Forensic Complexity*, 31 BEHAV. SCI. & L. 701, 708–09 (2013).

imaging of an individual but not qualified to testify about the design of fMRI studies.

The fourth issue relating to expertise is determined by the specific imaging modality: Who is qualified to order, administer, and interpret the data? While most neuroimaging modalities are in the realm of medical diagnostics, as explained above, fMRI has been used largely in basic research often led by non-physicians in an academic setting. However, despite PET and MRI being in the domains of diagnostic radiology and nuclear medicine respectively, a variety of non-radiologists and non-physicians have relied on these modalities in research and have been asked to testify about interpretations of these images.[32]

II. Scientific Evidence

Courts have long wrestled with science and experts in deciding cases and controversies, with some degree of success but certainly with some notable errors.[33] During the twentieth century, as scientific and expert evidence began to became more prominent in both civil and criminal litigation, many voiced concerns about the quality of scientific evidence admitted in the courts and the appropriate scope of expertise.[34] These concerns precipitated the so-called *Daubert* trilogy and the amendment to Federal Rules of Evidence ("FRE") 702.[35] This

32. *See id.* at 708, 713–14 (discussing the use of PET scan evidence to support claims of both traumatic brain injury and aberrant behavior not related to Alzheimer's disease).

33. Robin Feldman, The Role of Science in Law 148 (2009).

34. For more about the mid-century critiques of scientific evidence, see Giannelli, *supra* note 3, at 1208–28. For a detailed history of scientific evidence, see Tal Golan, *Revisiting the History of Scientific Expert Testimony*, 73 Brook. L. Rev. 879 (2008).

35. *See* Daubert v. Merrell Dow Pharms., Inc., 509 U.S. 579 (1993); Gen. Elec. Co. v. Joiner, 522 U.S. 136 (1997); Kumho Tire Co., Ltd. v. Carmichael, 526 U.S. 137 (1999). Federal Rule of Evidence 702 provides as follows:

> A witness who is qualified as an expert by knowledge, skill, experience, training, or education may testify in the form of an opinion or otherwise if:
>
> (a) the expert's scientific, technical, or other specialized knowledge will help the trier of fact to understand the evidence or to determine a fact in issue;
>
> (b) the testimony is based on sufficient facts or data;
>
> (c) the testimony is the product of reliable principles and methods; and
>
> (d) the expert has reliably applied the principles and methods to the facts of the case.

decisional shift and rule change have been part of the ongoing effort "to exorcise charlatanism and differentiate good science from bad"[36] in the courtroom; a lofty but challenging task.

The *Daubert* trilogy of Supreme Court decisions governing the admission of expert evidence in federal cases was intended to sharpen courts' focus on the quality of such evidence, requiring judges serve as the gatekeepers of expert evidence, sifting the evidentiary wheat from chaff—a daunting task for judges "largely untrained in science."[37] As part of this gatekeeping, courts have occasionally been guided by amicus briefs from groups of experts and, infrequently, by independently-retained court experts or science panels.[38] Typically, however, courts rely on competing partisan experts, colorfully described as "the legal system's [attempt] to grind truth from between the abrasive surfaces of two opposing parties . . . ."[39] A court's grasp of a given field of science and the requisite level of expertise required is often only as good as the messengers before them. It is a difficult task for courts to understand the boundaries of expertise in the area of neuroimaging evidence, particularly when the lawyers also may not understand the proper roles of various experts.

The use of mental health experts—currently psychiatrists and psychologists—to testify as experts on sanity, cognitive impairment, legal competence, and other matters in criminal cases has a long history in both U.S. courts and English common law.[40] Mental health experts frequently testify at all stages of the criminal proceeding, from competency hearings through capital case penalty phase hearings to

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FED. R. EVID. 702. Sections (a)–(c) were added in 2000 to reflect the *Daubert* trilogy and other cases. FED. R. EVID. 702 advisory committee's note to 2000 amendment.

36. Golan, *supra* note 34, at 942.

37. Daubert v. Merrell Dow Pharm., Inc., 43 F.3d 1311, 1316 (9th Cir. 1995).

38. *Daubert*, 509 U.S. at 590; FED. R. EVID. 706(a); Joe S. Cecil & Thomas E. Willging, *Accepting* Daubert*'s Invitation: Defining a Role for Court-Appointed Experts in Assessing Scientific Validity*, 43 EMORY L.J. 995, 995 (1994); *see* Andrew W. Jurs*, Science Court: Past Proposals, Current Considerations, and a Suggested Structure*, 15 VA. J.L. & TECH. 1, 18–23 (2010). Improving methods for evaluating expert testimony is not a new concept. As Professor Tal Golan explains, nearly all the reform proposals of the twentieth-century are traceable back to the nineteenth century. Golan, *supra* note 34, at 937.

39. Jones et al., *Neuroscientists in Court*, *supra* note 29, at 732.

40. Richard E. Redding, *The Brain-Disordered Defendant: Neuroscience and Legal Insanity in the Twenty-First Century*, 56 AM. U. L. REV. 51, 75–85 (2006); Godinez v. Moran, 509 U.S. 389, 404–07 (1993) (Kennedy, J., concurring in part and concurring in judgment).

provide critical, necessary testimony.[41] Yet, as long recognized, fact-finders are skeptical of expert testimony used to explain a defendant's past mental state and overwhelmingly discount the testimony of defense psychiatric and psychological experts.[42] Given this skepticism, defendants eagerly embraced functional neuroimaging to provide more compelling and "objective" proof of mental health impairments that might be regarded more favorably by juries, although questions remain about the relative success of such efforts.[43]

III. NEUROIMAGING EVIDENCE

Over the last decade, neuroimaging evidence has become increasingly prevalent in criminal cases. Empirical studies demonstrate that neuroimaging is often admitted as mitigating evidence in sentencing, competency hearings, and during trial as part of the defense.[44] Courts have frequently admitted nuclear medicine-based studies, including PET and SPECT in criminal trials on a range of mental health issues, both in the guilt phase of trials and in

41. The authors offer no opinion on the expertise of mental health expert witnesses who are testifying about matters other than structural and functional neuroimaging, although they recognize that there are contentious issues this subject also presents. Psychiatrists and psychologists are well-qualified to address many critical mental health matters in court.

42. Jane Campbell Moriarty, *Seeing Voices: Potential Neuroscience Contributions to a Reconstruction of Legal Insanity,* 86 FORDHAM L. REV. 599, 613 (2016); CHRISTOPHER SLOBOGIN, PROVING THE UNPROVABLE: THE ROLE OF LAW, SCIENCE, AND SPECULATION IN ADJUDICATING CULPABILITY AND DANGEROUSNESS (2007); MICHAEL L. PERLIN, THE JURISPRUDENCE OF THE INSANITY DEFENSE 144–45 (1994).

43. *See* Michael L. Perlin, *"And I See Through Your Brain": Access to Experts, Competency to Consent, and the Impact of Antipsychotic Medications in Neuroimaging Cases in the Criminal Trial Process*, 2009 STAN. TECH. L. REV. 4, 4; O. Carter Snead, *Neuroimaging and the "Complexity" of Capital Punishment*, 82 N.Y.U. L. REV. 1265, 1270 (2007). *But see generally* Farahany, *supra* note 14, at 507–08 (discussing the relative success of such evidence).

44. *See* Deborah W. Denno, *The Myth of the Double-Edged Sword: An Empirical Study of Neuroscience Evidence in Criminal Cases,* 56 B.C. L. REV. 493, 504 (2015) (discussing the use of neuroscience evidence in the guilt and sentencing phases of criminal cases and noting its frequent use as mitigation); Farahany, *supra* note 14 (documenting the rising use of neurobiological research for purposes of competency, guilt, and mitigation); Lyn M. Gaudet & Gary E. Marchant, *Under the Radar: Neuroimaging Evidence in the Criminal Courtroom*, 64 DRAKE L. REV. 577, 661 (2016) (concluding that evidence has been admitted in the guilt phase, penalty phase, and in competency hearings).

sentencing,[45] and fMRI expert evidence has been admitted as additional proof of psychopathy.[46] While the use of such evidence may have promise to improve legal decision making on issues of mental health, the use of such evidence has been described as "haphazard, ad hoc, and often ill conceived."[47]

While neuroscience research has grown exponentially over the last decades,[48] the number of publications about neuroscience and law, sometimes termed "neurolaw," has also increased dramatically.[49] Much of the academic scholarship has been devoted to questioning the reliability and relevance of neuroimaging evidence,[50] with less

45. *See* Nita Farahany, *Incriminating Thoughts*, 64 STAN. L. REV. 351, 374 (2012); Francis X. Shen, *Mind, Body, and the Criminal Law*, 97 MINN. L. REV. 2036, 2064–66 (2013); Moriarty et al., *supra* note 31, at 708–09 (discussing the use of PET scans as evidence in cases involving brain damage, toxic exposure, or illness).

46. Virginia Hughes, *Science in Court: Head Case*, 464 NATURE 340, 340 (2010). For reported cases disallowing fMRI evidence related to lie detection, see Wilson v. Corestaff Servs., L.P., 900 N.Y.S.2d 639, 642 (N.Y. App. Div. 2010); United States v. Semrau, 693 F.3d 510, 516 (6th Cir. 2012).

47. Farahany, *supra* note 14, at 488–89.

48. *See generally* Bandettini, *supra* note 15 (discussing the history, growth, and discoveries of fMRI research during the preceding twenty-year period).

49. The Law and Neuroscience Bibliography from the website of The MacArthur Foundation Research Network on Law and Neuroscience includes a graph indicating far less than 200 such publications by 2005, nearly 1,100 such publications by 2012, and roughly 1,700 by 2017. *Cumulative Total of Law and Neuroscience Publications: 1984–2017*, LAW & NEUROSCI., http://www.lawneuro.org/bibliography/bibliography2017.pdf [https://perma.cc/STH9-RKH5] (last visited Mar. 4, 2018) [hereinafter The Law and Neuroscience Bibliography]; *see also* Francis X. Shen, *The Law and Neuroscience Bibliography: Navigating the Emerging Field of Neurolaw*, 38 INT'L J. LEGAL INFO. 352, 358 (2010).

50. For a small sample of the scholarship, see, for example, Henry T. Greely & Anthony D. Wagner, *Reference Guide on Neuroscience*, *in* REFERENCE MANUAL ON SCIENTIFIC EVIDENCE 747, 776 (3d ed. 2011); The Law and Neuroscience Bibliography, *supra* note 49; Katherine Shats et al., *Don't Ask a Neuroscientist About Phases of the Moon: Applying Appropriate Evidence Law to the Use of Neuroscience in the Courtroom*, 25 CAMBRIDGE Q. HEALTHCARE ETHICS 712, 712 (2016); C.C. Meltzer et al., *supra* note 27, at 635; Daniel D. Langleben & Jane Campbell Moriarty, *Using Brain Imaging for Lie Detection: Where Science, Law and Research Policy Collide*, 19 PSYCHOL. PUB. POL'Y L. 222 (2013); Francis X. Shen & Owen D. Jones, *Brain Scans as Evidence: Truths, Proofs, Lies, and Lessons*, 62 MERCER L. REV. 861, 862 (2011); Brown & Murphy, *supra* note 27, at 1131–32.

attention devoted to the question of expert qualifications in this emerging and multidisciplinary field.[51]

Most of the academic analysis about functional neuroimaging evidence arises from the *Daubert* trilogy's focus on methods used in research, the relationship and distance between data and conclusions, and the "fit" of the proposed testimony to the issue in dispute.[52] To date, little attention has been given to the role of expert qualifications in most scholarship, both because witness expertise historically has been a low hurdle,[53] and because of the more acute concerns about legal reliability and the profound implications of such evidence.

Federal Rule of Evidence 702, the template for most state evidence rules, provides that a witness may be qualified as an expert by "knowledge, skill, experience, training, or education."[54] Written in the disjunctive, the rule permits an expert to be qualified in multiple ways and envisions various types of expertise.[55] Generally, however, there is

51. Publications raising the topic of neuroimaging expertise in practice or in forensic settings include Purvak Patel et al., *The Role of Imaging in United States Courtrooms*, 17 NEUROIMAGING CLINICS N. AM. 557, 560 (2007); Neil K. Aggarwal, *Neuroimaging, Culture, and Forensic Psychiatry*, 37 J. AM. ACAD. PSYCHIATRY & L. 239, 241 (2009); Elizabeth Ford & Neil Aggarwal, *Neuroethics of Functional Neuroimaging in the Courtroom*, *in* NEUROIMAGING IN FORENSIC PSYCHIATRY: FROM THE CLINIC TO THE COURTROOM 325, 331–32 (Joseph R. Simpson ed., 2012); Andreana Benitez et al., *Neuroimaging Training Among Neuropsychologists: A Survey of the State of Current Training and Recommendations for Trainees*, 28 CLINICAL NEUROPSYCHOL. 600 (2014) (discussing the benefits neuroimaging training could have in preparing neuroscientists to serve as expert witnesses); Christina T. Liu, Note, *Scanning the Evidence: The Evidentiary Admissibility of Expert Witness Testimony on MRI Brain Scans in Civil Cases in the Post-*Daubert *Era,* 70 N.Y.U. ANN. SURV. AM. L. 479, 518–19 (2015).

52. *See supra* note 50 and accompanying text.

53. Jennifer L. Mnookin, *Expert Evidence, Partisanship, and Epistemic Competence*, 73 BROOK. L. REV. 1009, 1016–17 (2008) (explaining that as a matter of historical review, judges rarely interrogated experts' bona fides in a rigorous manner, and such decisions were "virtually unreviewable on appeal"); *see also* DAVID FAIGMAN ET AL., MODERN SCIENTIFIC EVIDENCE: THE LAW AND SCIENCE OF EXPERT TESTIMONY § 22:9 (2017–2018 ed.) (stating that "[t]raditionally, all but the grossly unqualified experts were permitted to testify under Rule 702," but noting the change in many post-*Daubert* cases where experts have been rejected on the basis of their lack of qualifications).

54. *See supra* note 35, setting forth FRE 702.

55. The Advisory Committee notes to FRE 702 provides:

> The fields of knowledge which may be drawn upon are not limited merely to the "scientific" and "technical" but extend to all "specialized" knowledge. Similarly, the expert is viewed, not in a narrow sense, but as a person qualified by "knowledge, skill,

a discernable relationship between an expert's qualifications and expertise: The more technical the specialized knowledge and the less comprehensible it is to the jury, the more likely the court is to be demanding about qualifications.[56] The nature of the expert's opinion will determine the required qualifications, whether academic or experiential, but it should rise to a "meaningful threshold of expertise."[57]

Recognizing that expertise is often a question of weight of the evidence rather than admissibility, some courts have set the bar exceptionally low for qualifications, stating that experts need only "possess skill or knowledge greater than the average layman."[58] Other courts opine that experts need to be neither "blue-ribbon practitioners" with "optimal qualification[s],"[59] nor even "highly qualified in order to testify about a given issue."[60] Despite the rhetoric, many courts in the post-*Daubert* era have employed a more rigorous standard, often in complex civil cases involving medical device and malpractice[61] or in toxic tort cases.[62]

With respect to the expert testimony of physicians, courts currently scrutinize qualifications for specialties and are mindful of limiting the testimony of experts to questions within their specialized medical area and knowledge.[63] While non-physicians, such as nurses,

> experience, training or education." Thus within the scope of the rule are not only experts in the strictest sense of the word, *e.g.,* physicians, physicists, and architects, but also the large group sometimes called "skilled" witnesses, such as bankers or landowners testifying to land values.
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> Carnegie Mellon Univ. v. Marvell Tech. Grp., Ltd., 807 F.3d 1283, 1303 (Fed. Cir. 2015).

56. Judge Harvey Brown, *Eight Gates for Expert Witnesses*, 36 HOUSTON L. REV. 743, 759 (1999), citing 2 STEPHEN SALTZBURG ET AL., FEDERAL RULES OF EVIDENCE MANUAL 1220 (7th ed. 1998).

57. Prado Alvarez v. R.J. Reynolds Tobacco Co. Inc., 405 F.3d 36, 40 (1st Cir. 2005).

58. Elcock v. Kmart Corp., 233 F.3d 734, 741 (3d Cir. 2001) (quoting Waldorf v. Shuta, 142 F.3d 601, 625 (3d Cir. 1998)).

59. United States v. Vargas, 471 F.3d 255, 262 (1st Cir. 2006).

60. Huss v. Gaydon, 571 F.3d 442, 452 (5th Cir. 2009).

61. *See, e.g.*, Ralston v. Smith & Nephew Richards, Inc., 275 F.3d 965, 969–74 (10th Cir. 2001).

62. See FAIGMAN ET AL., *supra* note 53, § 22:9.

63. *See, e.g.*, Rheinfrank v. Abbott Labs., 680 F. App'x 369, 380 (6th Cir., 2017) (noting that several courts have "limited the testimony of medical experts to questions within their specialized medical ken"); *see also* Mathison v. Moats, 812 F.3d 594, 597 (7th Cir. 2016) (noting that a prison doctor was not qualified as an expert on cardiology); Warren v. Tastove, 240 F. App'x 771 (10th Cir. 2007) (upholding trial court decision to

scientists, and psychologists may be allowed to testimony about issues related to medicine, they are often prohibited from providing testimony that is considered to be within the sole expertise of physicians.[64] Thus, medical diagnoses, medical causation, and the need for and interpretation of medical tests are largely in the domain of physicians,[65] although there are exceptions.[66] And the substantial overlap between psychiatry and psychology expertise presents complicated questions as well.

The wide-ranging pursuits of the neuroscience field include intersecting and often overlapping areas of expertise among psychologists, research scientists, and various categories of physicians. Yet, lawyers and judges are not always aware—nor could they be—of the general boundaries of expertise and the precise boundaries of expertise in a given matter on a specific issue.

The well-credentialed researchers producing neuroimaging data might seem to be qualified as experts in court, given their extensive knowledge of the studies, methods used, data generated, study limitations, and error rates; and to the extent that is the scope of their testimony, they are likely well-qualified. But the analysis becomes difficult when one separates the question of knowledge of neuroimaging research from the diagnostic use of such evidence in a given

exclude testimony by orthopedic surgeon on whether the plaintiff could resume his former vocation); Brown, *supra* note 56, at 766–67 (noting the trend toward specific expertise, but recognizing exceptions to that rule).

64. *See* Carlson v. Bioremedi Therapeutic Sys., Inc., 822 F.3d 194, 200 (5th Cir. 2016).

65. *See, e.g.*, Edmonds v. Ill. Cent. Gulf R.R. Co., 910 F.2d 1284 (5th Cir. 1990) (deciding that a clinical psychologist, with "specialized training in the application of psychological principles to the assessment and treatment of people with psychological problems" was not qualified to testify about whether stress worsened a plaintiff's coronary artery disease. "[He] is not a medical doctor, and he is not involved in making medical diagnoses or ordering medical studies or tests. . . [this] is a medical issue that is plainly beyond this witness's expertise in the field of psychology"); Kellar v. Willis, 186 F. App'x 714 (8th Cir. 2006) (distinguishing between the practice of medicine and psychological expertise).

66. Moreover, the growing reliance upon nurse practitioners, physician assistants, and others in medicine may well change concepts of expertise. For more, see Lori B. Andrews, *The Shadow Health Care System: Regulation of Alternative Health Care Providers*, 32 HOUSTON L. REV. 1273 (1996) (discussing the growth and use of so-called alternative practitioners), and Thomas R. McLean, *The Schizophrenia of Physician Extender Utilization*, 20 ANNALS OF HEALTH L. 205 (2011) (discussing the role of physician extenders, such as nurse practitioners and physician assistants).

individual.[67] Evaluating the proposed testimony vis-à-vis the matter at issue, *i.e.,* the "task at hand,"[68] presents difficult questions of legal expertise in cases involving functional neuroimaging of an individual.

Three categories of professionals—physicians, psychologists, and doctoral-level research scientists—usually conduct functional neuroimaging research that relates to mental health issues. These doctoral-level scientists design the studies and oversee data collection, review the statistical analysis, and draft the findings, usually in the form of publication in peer-reviewed scientific journals. The research scientists may have degrees in one of many subspecialties of psychology, a PhD in a biomedical field such as Neuroscience, Physiology, Chemistry, Physics, or even Computer Science and Engineering. As many research scientists are far removed from the actual clinical practice of medicine or even psychology that may employ such research, their qualifications are usually insufficient to discuss the applicability of the research studies to an individual case. As a general matter, non-physician researchers are not qualified or licensed to prescribe or interpret functional neuroimages diagnostically. Thus, application of those studies to a given individual—which is often at issue in legal disputes—is generally outside of their area of competence.[69]

In the US, physicians receive a doctor of medicine ("M.D.") degree from an accredited school of medicine, followed by a residency training in one of about thirty recognized medical specialties, such as radiology, and often with additional fellowship training in a subspecialty, such as neuroradiology.[70] Physicians are licensed by a state to practice medicine, without distinction between specialties, so that from a licensing perspective, a radiologist could practice psychiatry without completing a residency training in psychiatry and vice versa. In reality, physicians are bound to practice within their specialty by their hospital bylaws and malpractice insurance.

Probably the largest category of doctoral level professionals who engage in both neuroimaging research and clinical practice are the

67. For more on the difference between diagnostic and framework expertise, see *supra* notes 29–31 and accompanying text.

68. Daubert v. Merrell Dow Pharms., Inc., 509 U.S. 579, 579 (1993); *see also* GIANNELLI, *supra* note 2, § 5:03, noting that an expert may be qualified in one aspect of a scientific technique but not qualified in another.

69. Those scientists, however, may be well-credentialed to explain data generated from studies for controversies in court, as occurred with criminal cases involving juveniles, referenced in note 29, *supra.*

70. *About Us*, ACCREDITATION COUNCIL FOR GRADUATE MED. EDUC., http://www.acgme.org/About-Us/Overview [https://perma.cc/E54Y-UNWV] (last visited Mar. 11, 2014).

clinical psychologists. Unlike research scientists, and similar to physicians, psychologists need to be licensed in a state in order to treat patients; unlike physicians, they are primarily trained in non-pharmacological treatments[71] for mental and behavioral disorders, *i.e.*, psychotherapy and psychological testing.

Of the various types of professionals involved in neuroimaging research, only physicians are actually licensed by a jurisdiction in which they practice to order a diagnostic imaging study and provide a diagnostic interpretation of such study, because both referral and interpretation constitute practice of medicine. Clinical psychologists are also qualified to diagnose and provide therapy to patients, and many are qualified to perform psychological testing of various types.[72] While clinical psychologists may rely on a physician's interpretation of medical images, neither they nor research scientists are generally qualified to interpret those images. Thus, they could not opine whether a brain area on a PET scan using radioactive glucose tracer is abnormally hypometabolic and has clinical significance or requires medical treatment.

There are, however, overlapping areas of expertise and differing opinion about the roles of psychiatrists and psychologists both in and out of the courtroom. As many psychological and neuroscience researchers spend most of their careers using functional neuroimaging, they often have greater knowledge of the functional neuroimaging research than those practicing psychiatrists, neurologists, and radiologists who do little or no neuroimaging research. Given these complementary areas of expertise, in is not surprising that courts are not focusing on the distinctions among physicians, clinical psychologists, and research scientists. While all three specialties might be qualified to testify about aspects of functional neuroimaging, there are limits to each profession's qualifications.

The scope of clinical psychologist's area of expertise has also become more complex over time. The American Psychological Association has developed a recognized subspecialty of Clinical Neuropsychology for doctoral-level psychologists, which raises another legal issue of relative spheres of expertise between clinical psychologists and neuropsychologists. However, as noted in a survey of those professionals, the neuroimaging training among those clinical neuropsychologists is widely divergent, raising further questions about what training constitutes sufficient courtroom qualifications to testify about neuroimaging.[73] While the authors of that article recommend training

71. Some states have begun to license psychotherapists to prescribe psychoactive medication. Melton et al., *supra* note 26, at 23.

72. *Id.* at 23–24.

73. Benitez et al., *supra* note 51, at 5–6.

in neuroimaging, they recognize that "no established guidelines exist for neuroimaging training among neuropsychologists."[74] Moreover, some of the psychologists who testify about the meaning of neuroimages have only a masters' level degree. Thus, there are serious questions about the specific qualifications that would qualify a psychologist to testify about neuroimages.

To date, some courts have allowed non-physicians to testify in a diagnostic fashion about structural and functional neuroimaging, generally not addressing the question of expertise. For example, in *Black v. Bell*,[75] the defendant was convicted of murder and sentenced to death.[76] He subsequently filed a petition for habeas corpus; part of which rested on a claim of mental retardation pursuant to *Atkins v. Virginia*,[77] which prohibits the execution of mentally retarded individuals.[78] As part of his proof, the petitioner introduced the testimony of a psychiatrist and a psychologist, both of whom reviewed MRI and PET scans and concluded that the defendant had "extensive brain damage that was likely caused by his mother's drinking alcohol while pregnant, but might also have been caused by other occurrences during his childhood."[79] The court did not comment on the relative qualifications of the experts but did grant defendant's petition to remand on the basis of *Atkins*.[80]

In *Simmons v. State*,[81] two defense psychologists testified in a post-conviction hearing about possible mental health evidence, based upon a PET scan of defendant's brain.[82] One testified that the PET scan confirmed his opinion that the defendant had brain damage that led to a lifetime of impulsivity, behavioral problems, and a "sort of pervasive maladjustment."[83] The other testified that the PET scan showed "unilateral hypometabolism in a key structure in the middle of the brain called the thalamus," and testified that the defendant's cognitive impairment, dyslexia, impulsive behavior and acting out were consistent with thalamic dysfunction.[84] The prosecution expert

74. *Id.* at 8.

75. 664 F.3d 81 (6th Cir. 2011).

76. *Id.* at 82.

77. 536 U.S. 304 (2002).

78. *Id.* at 304.

79. *Black*, 664 F.3d at 88.

80. *Id.* at 101.

81. 105 So. 3d 475 (Fla. 2012).

82. *Id.* at 505.

83. *Id.* (internal quotation marks omitted).

84. *Id.*

was a physician who was board-certified, *i.e.*, residency-trained, in both Diagnostic Radiology and Nuclear Medicine and a Professor of Radiology.[85] He testified that the PET scan, including the thalamus, was within normal range, and that PET cannot be used with any degree of reliability to diagnose behavioral problems.[86] Perhaps paradoxically, the court's expressed concern about expertise only related to the physician testifying about behavior—without recognizing that the physician may have been the only one among the witnesses qualified to testify both about abnormalities on individual PET scans and their clinical significance.[87]

In a federal death penalty case, the defense sought to introduce diagnostic testimony from an expert who was both a clinical psychologist and a distinguished researcher to discuss an MRI and PET scan as proof of the defendant's underlying mental illness.[88] The reliability of the PET scan evidence was challenged by the government's experts, one of whom was a practicing neurologist with fellowship training in nuclear medicine.[89] The court ultimately barred the PET scan evidence on reliability grounds but did not address the issue of whether the experts were sufficiently qualified to testify about PET scan evidence.[90]

In another capital case, an influential research psychologist testified during the sentencing phase that the defendant's fMRI results were consistent with psychopathy, based upon his extensive fMRI research[91] and the fMRI testing of the defendant he had conducted.[92] Uniquely in that case, the expert testifying had a doctorate in both neuroscience and psychology, was a recognized expert in clinical psychology involving the diagnosis of psychopathy, and had published extensive peer-reviewed research to correlate fMRI data with psychological diagnoses of psychopathy. Most experts, however, do not bring to the court such extensive expertise. And while such "blue ribbon" expertise is not the standard in courts, there should be better guidelines to determine who is, and who is not, qualified to assist the finder of fact in making a decision.

85. *Id.* at 506.

86. *Id.*

87. *Id.*

88. United States v. Montgomery. 635 F.3d 1074, 1082 (8th Cir. 2011).

89. *Id.* at 1088.

90. *Id.* at 1083.

91. Hughes, *supra* note 46, at 340–41.

92. *Id.* at 340.

In some cases, physicians testify about the abnormalities on PET scans while clinical psychologists testify about the mental health implications of the neuroimages or testify that the images support their psychological diagnosis. While this approach avoids the non-physician directly evaluating a PET scan, it addresses neither the concern that functional neuroimages have very limited applications in clinical psychiatry[93] nor the questions presented about non-physicians testifying diagnostically about neuroimages.

Recommendations and Conclusion

In his 1998 article in *Science*, Justice Breyer states that "[t]he law must seek decisions that fall within the boundaries of scientifically sound knowledge . . . . There is an increasingly important need for law to reflect sound science."[94] Science, law, and medicine have different purposes and methods and assess certainty in varying ways. In the courtroom they are interdependent, with clinical medicine often mediating between law and biological science. In the case of neuroimaging, the rapid growth of science has been producing new information faster than clinical medicine could test and learn. Medical and psychological training curricula may need to devote greater attention to the emerging imaging technologies even before they are adopted, and medical and clinical specialties need to govern their members about the proper role of specialization when testifying in court.[95]

For testimony involving structural imaging such as MRI, CAT, x-ray and nuclear medicine techniques including PET and SPECT, we believe that a medical degree is critical for diagnostically-based

93. *See* Farah & Gillihan, *supra* note 21, at 2 ("Aside from its use to rule out potential medical causes of a patient's condition, for example a brain tumor, neuroimaging is not used in the process of psychiatric diagnosis.").

94. Stephen Breyer, *The Interdependence of Science and Law*, 280 Sci. 537, 537–38 (1998).

95. Professor Jennifer Bard explains why experts giving opinions on future dangerousness in capital cases do not have a data-based premise for their opinions, noting a lack of "peer-reviewed, published research based on a study of defendants who have been convicted of a capital crime and are facing the death penalty." Jennifer S. Bard, *Diagnosis Dangerous: Why State Licensing Boards Should Step in to Prevent Mental Health Practitioners from Speculating Beyond the Scope of Professional Standards*, 2015 Utah L. Rev. 929, 947. She urges both American Psychiatric and American Psychological Associations to require state licensing boards to assure that these experts do not testify beyond the scope of medical support or evidence. *Id.* at 929. The authors agree that the licensing boards could have a strong normative effect on the scope of expert's testimony.

expertise and a relevant subspecialty of radiology, neuroradiology or nuclear medicine is preferred. Professional Radiology and Nuclear Medicine societies anticipate that PET and SPECT scan are ordered and interpreted by physicians with appropriate qualifications and experience in the field and make no provisions for involvement of non-physicians other than qualified technicians performing the scans.[96]

With respect to fMRI, the issue is more complicated and the role of expertise more clouded. As noted above, with the exception of dementia, fMRI is not used in clinical psychiatry and the only clinical application of fMRI recognized by the American College of Radiology ("ACR") appears to be pre-surgical mapping of brain function. Much of the research using fMRI is undertaken by psychologists in academic settings, with physicians only reviewing scans for incidental findings.[97] As fMRI is used for foundational research, the scope of expertise for those researchers would likely extend to the data and interpretation of those research studies.

The principles governing other forms of functional neuroimaging would suggest that diagnostic fMRI is in the domain of medicine. However, fMRI in many cases requires the patient to perform, during the scan, a standardized task variably referred to as "neurofunctional" or "activation" task that generates a motor, sensory or language function of interest, such as finger-tapping. According to American Medical Association's ("AMA") Current Procedural Terminology ("CPT") codes created for fMRI in 2007, both physicians and clinical psychologists may administer and interpret fMRI studies that involve such "neurofunctional testing."[98] This suggests that the AMA CPT panel considers these two professions interchangeable in at least some parts of the fMRI domain. However, since this CPT is intended for

96. *See ACR Practice Parameter for Performing and Interpreting Magnetic Resonance Imaging (MRI)*, AM. C. RADIOLOGY (2017), https://www.acr.org/-/media/ACR/Files/Practice-Parameters/mr-perf-interpret.pdf?la=en [https://perma.cc/TU53-67GD]; *ACR-ASNR-SPR Practice Parameter for the Performance and Interpretation of Magnetic Resonance Imaging of the Brain*, AM. C. OF RADIOLOGY (Res. 6–2013) https://www.acr.org/-/media/ACR/Files/Practice-Parameters/mr-brain.pdf?la=en [https://perma.cc/2XMG-5GW2]; *The SNM Procedure Guideline for General Imaging V6.0*, SOC'Y NUCLEAR MED. (2010), http://interactive.snm.org/docs/General_Imaging_Version_6.0.pdf [https://perma.cc/RM6M-W4KS].

97. For more on issues related to incidental findings from MRI and fMRI studies, see Kyoko Takashima et al., *Discovery and Informing Research Participants of Incidental Findings Detected in Brain Magnetic Resonance Imaging Studies: Review and Multi-Institutional Study*, BRAIN & BEHAV., May 2017.

98. John Hart, Jr., M.D., et al., *Clinical Functional Magnetic Resonance Imaging*, 20 COGNITIVE BEHAVIORAL NEUROLOGY 141, 141–44 (2007).

brain mapping prior to surgery,[99] this does not indicate a general endorsement of non-physicians ordering or interpreting fMRI of individuals outside of recognized medical indications.

For their part, the courts' analysis of functional neuroimaging would be helped if they had a clearer understanding of the academic and professional structure of the interrelated fields that produce the neuroimaging science. While courts will continue to rely on the "dueling experts" model, we believe that there are additional routes to provide scientific and medical guidance to the courts, including the use of consensus opinions by professionals in the various fields.

As a result of the *Daubert* trilogy, The Reference Manual on Scientific Evidence, the many programs presented on Science for Judges, the Supreme Court's encouragement to appoint independent experts,[100] and the proposed use of Science Panels for complex litigation,[101] there has been much effort to improve the communication between science, medicine, and law. But as is widely agreed, most of these suggested methods to improve the communication have not been as successful as hoped. There is more to be done.

Another critical way to help bridge the divisions among science, medicine and law is greater reliance upon practice guidelines of the relevant professional groups, such as the AMA, the American Psychiatric Association, the American Psychological Association, the ACR, and the Society of Nuclear Medicine ("SNM"), as well as recommendations by specially convened conferences such as the Consensus Report of the Working Group on Psychiatry.[102]

With hope, this trend will continue. When experts can reach consensus on a variety of issues, courts are provided with epistemically competent information by which to evaluate the experts in their courtrooms. There should be greater discussion among psychiatric and psychological societies on the role of functional neuroimaging for mental health-related issues. Such a collaboration would be of great use to the courts and could improve the quality of judicial gatekeeping with respect to expertise.

99. *Id.* at 144.

100. *See* Daubert v. Merrell Dow Pharms., Inc., 509 U.S. 579, 589 (1993) (stating that the Federal Rules of Evidence have a "permissive backdrop" for expert testimony); FED. R. EVID. 706.

101. Jurs, *supra*, note 38, at 18–19.

102. We also echo Professor Bard's suggestion that licensing bodies could have more input into overseeing the proper limits of expert witness testimony.