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Visions of Deception: Neuroimaging and the Search for Evidential Truth

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VISIONS OF DECEPTION: NEUROIMAGES AND THE SEARCH FOR TRUTH

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I. INTRODUCTION

Some neuroscientists claim they can visualize brain images of deception,¹ an idea which piques our imagination and excites our

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1. See, e.g., D.D. Langleben et al., *Brain Activity During Simulated Deception: An Event-Related Functional Magnetic Resonance Study*, 15 *NEUROIMAGE* 727, 731 (2002) (stating that results indicate that fMRI can detect neural correlates of cognitive differences between truth and deception); K. Luan Phan et al., *Neural Correlates of Telling Lies: A Functional Magnetic Resonance Imaging Study at 4 Tesla*, 12 *ACAD. RADIOLOGY* 164, 169 (2005) (discussing the different brain regions that appear to be associated with deception); F. Andrew Kozel et al., *Detecting Deception Using Functional Magnetic Resonance Imaging*, 2005 *J. BIO. PSYCHIATRY* 605, 611 (2005) (claiming that using fMRI, scientists were able to detect deception with a cooperative individual); G. Ganis et al., *Neural Correlates of Different Types of Deception: An fMRI*

deepest concerns. At the Neuroscience, Law & Government Symposium, two scientists described their research on the neuroimaging of deception while other scholars considered the benefits, shortcomings, and dangers of such neuroimages. The foundational philosophical concern, of course, is whether we think it is wise to allow the government and justice system to invade the privacy of thought: the last great wilderness on Earth.

As a matter of evidence, however, the science poses formidable juridical concerns about defining deception and determining what can be properly inferred from the images generated. As this introduction details briefly, the historical use of various forms of forensic science should alert us to the potential dangers that may be implicated in the uses of these new images. And as the article explains, the neuroimages of deception are far from courtroom-ready.

For those scientists attempting to depict neuroimages of deception, adequately defining the concept of deception is more complicated and outcome-determining than one might imagine: is it uttering false words, responding misleadingly to requests to push one button or another, or simply attempting to think untrue thoughts on demand?² And while defining deception is a difficult problem,³ perhaps another focus needs to be not on deception, but on what we mean by truth. One of the primary goals of trials, we repeat like a mantra, is the search for truth.⁴

Investigation, 13 CEREBRAL CORTEX 830, 833 (2003) (finding that patterns of brain activation are different when people tell lies than they are when people tell the truth).

2. See, e.g., Phan et al., *supra* note 1, at 166 (noting that subjects were instructed to lie by pressing buttons about certain playing cards); Langleben et al., *supra* note 1, at 729 (noting that subjects were told they could keep a reward if they kept the identity of the card from the computer); Sean A. Spence et al., *Speaking of Secrets and Lies: The Contribution of Ventrolateral Prefrontal Cortex to Vocal Deception*, 40 NEUROIMAGE 1411, 1413 (2008) (noting that subjects had the choice of when to be truthful or when to deceive when answering questions vocally); F. Andrew Kozel et al., *A Pilot Study of Functional Magnetic Resonance Imaging Brain Correlates of Deception in Healthy Young Men*, 16 J. NEUROPSYCHIATRY CLIN. NEUROSCIENCE 295, 298 (2004) (noting that subjects were instructed to deceptively point toward the object that did not contain hidden money).

3. Various studies define deception in different ways. Compare, e.g., Ganis et al., *supra* note 1, at 830 (defining deception as “when one person attempts to convince another to accept as correct what the prevaricator believes is incorrect”), with Kozel et al., *supra* note 2, at 295 (2004) (defining deception as the “purposeful misleading of another”). Other studies were designed to distinguish between erroneous memories and intentional deception. See Tatia M.C. Lee et al., *Are Errors Differentiable from Deceptive Responses when Feigning Memory Impairment? An fMRI Study*, 69 BRAIN & COGNITION 406, 407 (2009); Nobuhito Abe et al., *Neural Correlates of True Memory, False Memory, and Deception*, 18 CEREBRAL CORTEX 2811, 2811 (2008).

4. See, e.g., FED. R. EVID. 102 (providing that “[t]hese rules shall be construed to secure fairness in administration, elimination of unjustifiable expense and delay, and promotion of growth and development of the law of evidence to the end that the truth may be ascertained and proceedings justly determined”).

As if truth is objective, discoverable, and unchanging. But perception, viewpoint, bias, error, and interpretation clearly affect one's construction of truth. Like memory, truth may well be reconstructive,⁵ as may be the very idea of evidentiary reliability.⁶ In our evidential search for truth, there has been an historical belief from one generation to the next that science will lead us to truth. Trials rely on fingerprint and DNA comparisons, ballistics and tool marks, child sexual abuse experts, and opinions from physicians. Nevertheless, as we know both from history and from the analysis of data generated by the Innocence Project exonerations, using experts to prove the truth has often been a flawed endeavor.⁷ As an empirical study of the first 200 defendants exonerated by the innocence project concludes, faulty "[f]orensic evidence was the second leading type of evidence supporting these erroneous convictions."⁸ Although possibly possessed of fine intentions, experts make mistakes and no matter how good the science, there is always an expected rate of error.⁹ Despite those experts who claim their form of expertise is infallible, science disagrees.¹⁰

5. "[M]emory representations are not static but rather are subject to considerable change over time. Details may be lost and information in storage may be modified so as to increase its consistency vis-à-vis underlying knowledge." Peter A. Ornstein, Stephen J. Ceci & Elizabeth F. Loftus, *Adult Recollections of Childhood Abuse: Cognitive and Developmental Perspectives*, 4 PSYCHOL. PUB. POL'Y & L. 1025, 1034 (1998). Perhaps truth, like goodness, is not as clear-cut as one would hope.

6. Professor Jennifer Mnookin makes a related point in discussing the history of testimony about fingerprint comparisons:

There is no determinable thing called reliability that exists apart from our conceptions of reliability. Whether something is truly reliable when seen from some idealized Archimedean vantage point is simply the wrong question, for the Archimedean vantage point . . . eludes us. With the passage of time, our perceptions of reliability may change; we may come to believe that something we used to believe is no longer credible. But our new view as much as our old view is a 'mere' perception of reliability.

Jennifer L. Mnookin, *Scripting Expertise: The History of Handwriting Identification Evidence and the Judicial Construction of Reliability*, 87 VA. L. REV. 1723, 1743 (2001).

7. See Facts on Post-Conviction DNA Exonerations, <http://www.innocenceproject.org/Content/351.php> (last visited Mar. 12, 2009) (discussing convictions that resulted from flawed forensic science); Brandon L. Garrett, *Judging Innocence*, 108 COLUMB. L. REV. 55, 82-83 (2008); Jane Campbell Moriarty, "Misconvictions," *Science, and the Ministers of Justice*, 86 NEB. L. REV. 1, 7 (2007) (both discussing the role of forensic science errors in wrongful convictions).

8. Garrett, *supra* note 7, at 81.

9. See 1 DAVID L. FAIGMAN ET AL., MODERN SCIENTIFIC EVIDENCE: THE LAW AND SCIENCE OF EXPERT TESTIMONY § 1:20 (2005) (discussing the concept that all applied science has some error rate).

10. Compare *United States v. Havvard*, 117 F. Supp. 2d 848, 854, *aff'd*, 260 F.3d 597, 599 (7th Cir. 2001) (noting that the government's fingerprint comparison expert testified that the rate of error is essentially zero), with Simon A. Cole, *More than Zero: Accounting for Error in Latent*

Most recently, we learned again the potential fallibility of scientific evidence when the National Academy of Sciences issued its report on forensic science (“NAS Report”), questioning the foundation for much of the forensic science evidence so many courts have routinely admitted. The NAS Report concludes that the forensic science community of professionals has fallen far short in establishing either the validity of their approach or the accuracy of their conclusions. The courts, it notes, have been wholly ineffective in their gate-keeping obligations with respect to forensic science.¹¹

In the evidential search for truth via the medium of science, we are often concerned with the questions and problems of causation in trials, without recognizing the frequent tendency to erroneously infer causation. With new scientific discoveries possessing forensic application, there is the always-present danger of confusing correlation with causation, assuming a cause and effect relationship where none exists. It is a human tendency to make inferential leaps of causation—what we might term insights.¹² However, a recurrent problem with this inferential Archimedes-like leap from the bathtub is that it is often laden both with error and bias.¹³

During the Salem witchcraft trials, Cotton Mather consulted leading treatises on the scientific proof of witchcraft—as science was understood in the Seventeenth Century.¹⁴ In large part, Mather, who fancied himself a man of science, was not impressed with the use of ordeals and torture: “going to the Devil for help against the Devil,” as he might have put it.¹⁵

Fingerprint Identification, 95 J. CRIMINAL L. & CRIMINOLOGY 985, 987-88 (2005) (noting that despite claims that fingerprint comparison is infallible, it is far from error free), and Faigman, *supra* note 9. See NATIONAL RESEARCH COUNCIL, COMM. ON IDENTIFYING THE NEEDS OF THE FORENSIC SCIENCE COMMUNITY, STRENGTHENING FORENSIC SCIENCE IN THE UNITED STATES: A PATH FORWARD 4-5 (2009), available at <http://www.nap.edu/catalog/12589.html> [hereinafter NAS FORENSIC SCIENCE REPORT] (prepublication copy).

11. NAS FORENSIC SCIENCE REPORT, *supra* note 10, at 3-19.

12. See generally BERNARD J. F. LONERGAN, *INSIGHT: A STUDY OF HUMAN UNDERSTANDING* (3d ed. 1970) (on the nature of insight); Mary Ann Glendon, *Why Cross Boundaries?*, 53 WASH. & LEE L. REV. 971, 974-77 (1996) (discussing the concept of insight).

13. See, e.g., D. Michael Risinger et al., *The Daubert/Kumho Implications of Observer Effects in Forensic Science: Hidden Problems of Expectation and Suggestion*, 90 CAL. L. REV. 1, 13-15 (2002) (discussing, *inter alia*, problems of the expectation bias in forensic science). See NAS FORENSIC SCIENCE REPORT, *supra* note 10, at 4-5 (discussing the potential bias problems in laboratories).

14. See generally Jane Campbell Moriarty, *Wonders of the Invisible World: Prosecutorial Syndrome and Profile Evidence in the Salem Witchcraft Trials*, 26 VT. L. REV. 43 (2001) (discussing the witchcraft trials in depth).

15. *Id.* at 59 & n.94 (citing Wendel D. Craker, *Spectral Evidence, Non-Spectral Acts of Witchcraft, and Confession at Salem in 1692*, 40 HIST. J. 331, 343 (1997)).

Rather, he was most impressed with a scientific causation argument: If, after a suspected witch curses, there follows death, illness or affliction, there is a presumption of witchcraft.¹⁶ Thus, in the Bridget Bishop trial, evidence was introduced that after Bishop had quarreled with a particular family, the family's pig was taken with strange fits and began foaming at the mouth; these events were believed to be sure evidence that Bishop had bewitched the pig. This supposed relationship, which I have termed elsewhere "Bewitched Pig Syndrome," was considered solid, scientific evidence of witchcraft for more than a century.¹⁷ Today, we might be inclined to note the "*post hoc propter hoc*" fallacy—"after which, because of which."¹⁸

Contemporary judges and juries are unlikely to be impressed by "Bewitched Pig Syndrome" testimony.¹⁹ Yet many, both in the courtroom and outside of it, have faith in unproven causation. Consider the prevalence of legal claims resting on unproven causation and the public's trust in the efficacy of "miraculous" but untested herbal cures.²⁰ While scientists recognize that the plural of anecdote is not data but simply anecdotes,²¹ courts and the public are not so convinced.

In contraposition to most forensic science, polygraph evidence has encountered many stones in the pass-way to becoming courtroom evidence. The Supreme Court majority determined there was no consensus as to the reliability of polygraph evidence, and a majority of state and federal courts disallow it.²² Nonetheless, I do not believe courts are primarily concerned with the reliability of such instruments, given their willingness to routinely admit all types of evidence with proven track records of unreliability with nary a mention of such

16. *Id.* at 60-61 (discussing the Salem judges' reliance on William Perkins' *Discourse of the Damned Art of Witchcraft* and Richard Bernard's *Guide to Grand-Jury Men*).

17. *Id.* at 71.

18. "Which/witch" pun unintended but appreciated.

19. *But see* David L. Faigman, *The Syndromic Lawyer Syndrome: A Psychological Theory of Evidentiary Munificence*, 67 U. COLO. L. REV. 817, 817 (1996) (discussing relaxed evidentiary standards that courts employ to admit syndrome evidence).

20. *See, e.g., In re Breast Implant Litig.*, 11 F. Supp. 2d 1217, 1227 (D. Colo. 1998) (concluding that no controlled epidemiological study found a causative relationship between silicone breast implants and any known connective-tissue or autoimmune disease); ROBERT L. PARK, *VOODOO SCIENCE: THE ROAD FROM FOOLISHNESS TO FRAUD* 46-48 (2000) (describing the public's belief in alternative healing, despite the lack of a foundation for many claims).

21. The proper attribution to the author of this phrase seems unlikely. For more on the murky origins of the excellent but difficult-to-attribute phrase, see *The Matthew Effect*, <http://bearcastle.com/blog/?m=20050808> (last visited Mar. 12, 2009).

22. *United States v. Scheffer*, 523 U.S. 303, 309-11 (1998) (discussing the scientific disagreement of polygraph reliability and courts' widespread disfavor of such evidence).

concerns.²³ Rather, the judicial distain seems to center on expert evidence that opines on whether a given witness is telling the truth.²⁴ Courts' disfavor of the polygraph may be due to their long-stated appreciation of juries' ability to weigh credibility or the seemingly innate dislike we all share of our private thoughts being exposed.

As a form of expert testimony, polygraph evidence is riddled with causation problems. A key concern is that it conflates correlation with causation; its design measures anxiety or arousal as manifested in blood pressure, galvanic skin response, and respiration, resting on the assumption that lying will provoke an anxious response.²⁵ But some polygraph subjects are not anxious and do not exhibit physiological correlates of anxiety.²⁶ And asking an innocent person "did you kill John Doe" may well evoke an anxious (but believed to be *guilty*) reaction. Additionally, measuring physiological responses to a question about murder against a control question like "did you ever steal anything as a child" may not be sufficiently discerning to determine serious lies from truth, since such a control question cannot pose the same level of stress that the real life questions can.²⁷ Thus, the first problem is that the polygraph uses anxiety as a proxy for guilt, both overreaching and under-reaching, not recognizing that while there may often be some correlation between anxiety and guilt, the proof of actual causation is not as surefooted as claimed. The second problem is that it is incredibly difficult to create real-world consequences in control questions. The third problem is that countermeasures are potentially effective against the polygraph, competently disguising a "guilt" reaction.²⁸

The use of science in the search for truth poses consistent evidentiary problems of definition, causation, validity, accuracy, inferential conclusions unsupported by data, and real-world

23. See, e.g., *Barefoot v. Estelle*, 463 U.S. 880, 899, n.7 (1983) (upholding the decision to admit expert testimony about future dangerousness even though experts had indicated it might be accurate in only one of three predictions); *United States v. Green*, 405 F. Supp. 2d 104, 122 (D. Mass. 2005) (discussing the unreliability of toolmark and ballistic evidence based on scholarly criticism but noting that "court after court" has allowed its admission); NAS FORENSIC SCIENCE REPORT, *supra* note 10, at 3-19.

24. 1 JANE CAMPBELL MORIARTY, PSYCHOLOGICAL AND SCIENTIFIC EVIDENCE IN CRIMINAL TRIALS § 8:23, at 8-34 n.4 (2008) (citing cases disallowing expert testimony about whether a child was being truthful in alleging sexual abuse).

25. See, e.g., Ganis et al., *supra* note 1, at 830. See NATIONAL RESEARCH COUNCIL, COMM. TO REVIEW THE SCIENTIFIC EVIDENCE ON THE POLYGRAPH, THE POLYGRAPH AND LIE DETECTION 2-3 (2003) [hereinafter POLYGRAPH AND LIE DETECTION].

26. Ganis et al., *supra* note 1, at 830.

27. See, e.g., Langleben et al., *supra* note 1, at 731.

28. See, e.g., POLYGRAPH AND LIE DETECTION, *supra* note 25, at 139-40.

complications. And these evidentiary problems may well be implicated in the forensic use of neuroimages of deception. This article first briefly describes the various types of neuroimaging used to detect deception and describes some of the specific criticisms that have been leveled at the science. Second, the article outlines the standards governing admissibility and explains why the research to date does not yet meet any recognized standards of admissibility. Third, and finally, the article suggests that courts act with restraint in deciding questions of admissibility of such evidence, recognizing the lessons of historical experience with forensic science.

II. THE NEUROIMAGING OF DECEPTION

A. Functional Magnetic Resonance Imaging as a Detection Device

Functional magnetic resonance imaging (fMRI) has created a new way of visualizing brain activity and allows researchers to examine the brain with “higher sensitivity and accuracy . . . [and] view the brain ‘in action.’”²⁹ While MRI visualizes anatomical details in living things by considering magnetic charges, fMRI records “the difference between oxygenated and nonoxygenated blood cells due to their magnetic charges, so more active neurons can be distinguished from less active ones.”³⁰

Distinct from MRI, fMRI is correlated with brain function rather than brain structure.³¹ Thus, when an experimental subject is assigned specific tasks or functions, the fMRI seeks to detect the correlation between mental activities and activated neural systems.³² Although based on the same technology as MRI, fMRI measures localized changes in the brain as an individual is performing a selected task.³³ Unlike some other forms of neuroimaging, such as CAT scans and MRI, which appear in shades of gray, fMRI data are depicted as vivid and colorful

29. Jana L. Bufkin & Vickie R. Luttrell, *Neuroimaging Studies of Aggressive and Violent Behavior*, 6 TRAUMA VIOLENCE AND ABUSE 176, 176 (2005).

30. JONATHAN D. MORENO, MIND WARS: BRAIN RESEARCH AND NATIONAL DEFENSE 98 (2006).

31. Stephen B. Billick & Stephen P. Sullivan, *Neuroimaging in Child and Adolescent Psychiatry*, in PRINCIPLES AND PRACTICE OF FORENSIC PSYCHIATRY 463, 465 (Richard Rosner ed., 2d ed. 2003).

32. MORENO, *supra* note 30, at 98–99.

33. Stacey A. Tovino, *The Confidentiality and Privacy Implications of Functional Magnetic Resonance Imaging*, 33 J.L. MED & ETHICS 844, 844 (2005).

images in three-dimensional computer-generated images of the brain.³⁴ Researchers have used fMRI to study a range of conditions and illnesses, including Alzheimer's disease and various psychiatric disorders such as schizophrenia and addiction.³⁵ To date, however, few courts have admitted fMRI evidence at trial.³⁶

In recent years, neuroscientists have used fMRI technology to attempt to identify brain regions associated with deception.³⁷ Neuropsychological studies typically rely on blood oxygenation level dependent ("BOLD") fMRI, which "track[s] the changes in blood flow that correspond to changes in local brain activity."³⁸

Daniel Langleben and his fellow researchers concluded, after a small study, that fMRI could detect cognitive neurophysiological differences between deception and truth. "[T]here is a neurophysiological difference between deception and truth at the brain activation level that can be detected with fMRI."³⁹ Other research studies have made similar claims.⁴⁰ Dr. Steven Laken, CEO and

34. Jennifer Kulynych, Note, *Psychiatric Neuroimaging Evidence: A High-Tech Crystal Ball?*, 49 STAN. L. REV. 1249, 1257 (1997).

35. Tovino, *supra* note 33, at 845.

36. Jane Campbell Moriarty, *Flickering Admissibility: Neuroimaging Evidence in the U.S. Courts*, 26 BEHAV. SCI. L. 29, 39 (2008).

37. MORENO, *supra* note 30, at 103. See, e.g., Phan et al., *supra* note 1, at 169 (discussing fMRI results indicated which regions of the brain appear to be engaged when subjects engaged in deceptive responses).

38. Daniel D. Langleben, Frank M. Dattilio & Thomas G. Guthei, *True Lies: Delusions and Lie-Detection Technology*, 34 J. PSYCHIATRY & L. 351, 359 (2006). My description of fMRI is, by necessity, greatly simplified. For greater technical explanation of how fMRI functions and its limitations, see Nikos K. Logothetis, *What we can and what we cannot do with fMRI*, 453 NATURE 869 (2008); David J. Heeger & David Ress, *What Does fMRI Tell Us About Neuronal Activity?*, 3 NATURE REVIEWS 143 (2002).

39. Langleben et al., *supra* note 1, at 731.

40. Langleben, Dattilio, & Guthei, *supra* note 38, at 360; accord Langleben et al., *supra* note 1, at 731 (results indicated that fMRI can detect neural correlates of cognitive differences between truth and deception); Tatia M.C. Lee et al., *Lie Detection by Functional Magnetic Resonance Imaging*, 15 HUMAN BRAIN MAPPING 157 (2002) [hereinafter *Lie Detection*]; Andrew Kozel et al., *Functional MRI Detection of Deception After Committing a Mock Sabotage Crime*, 54 J. FORENSIC SCIENCE 220 (2008) [hereinafter Kozel, *Mock Crime*]; Donald H. Marks, Mehdi Adineh, & Sudeepa Gupta, *Determination of Truth from Deception Using Functional MRI and Cognitive Engrams*, 5 THE INTERNET J. RADIOLOGY (2006), http://www.ispub.com/journal/the_internet_journal_of_radiology/volume_5_number_1_35/article_printable/determination_of_truth_from_deception_using_functional_mri_and_cognitive_engrams.html; Spence et al., *supra* note 2; Sean A. Spence et al., *'Munchausen's Syndrome by Proxy' or a 'Miscarriage of Justice'? An Initial Application of Functional Neuroimaging to the Question of Guilt Versus Innocence*, 23 EUROPEAN PSYCHIATRY 309 (2008); Matthias Gamer et al., *Covariations among fMRI, Skin Conductance, and Behavioral Data During Processing of Concealed Information*, 28 HUMAN BRAIN MAPPING 1287 (2007); Feroze B. Mohamed et al., *Brain Mapping of Deception and Truth Telling About an Ecologically Valid Situation: Functional MR Imaging and Polygraph Investigation—Initial Experience*, 238

President of Cephos Corporation, a company designed in part to provide neuroimaging deception detection through the use of fMRI, has likewise published initial research suggesting that fMRI can detect deception in an individual.⁴¹ His website for Cephos, however, goes further, suggesting that fMRI to test for deception is “likely admissible in court” since it meets the reliability standards for admissibility.⁴² As more fully set forth *infra*, such a claim is wholly insupportable.

B. Shortcomings of fMRI to Detect Deception

Although the fMRI studies of deception done to date are both fascinating and provocative, there is much agreement that the science is in its early stages and is not at all ready to be admissible evidence. In a recent article published in a British Psychological Society Journal, Dr. Sean A. Spence, a researcher involved in the field, notes that there are roughly only sixteen published peer-reviewed studies from essentially four groups of reviewers.⁴³ To date, he critiques, there is a marked absence of replication by investigators of their own key findings and there are inconsistencies in the procedures and methodologies used by researchers.⁴⁴ Another group of scientists involved in the field has noted that results are not always consistent or reproducible.⁴⁵ A third group of scientists working in the area expresses concern that the design and analysis methods across the studies vary considerably, “making it

RADIOLOGY 679 (2006); Frank Andrew Kozel, Tamara M. Padgett, & Mark S. George, *A Replication Study of the Neural Correlates of Deception*, 118 BEHAVIORAL NEUROSCIENCE 852 (2004); Kozel et al., *supra* note 2; Daniel D. Langleben et al., *Telling the Truth from Lie in Individual Subjects with Fast Event-Related fMRI*, 26 HUMAN BRAIN MAPPING 262 (2005); Christos Davatzikos, *Classifying Spatial Patterns of Brain Activity with Machine Learning Methods: Application to Lie Detection*, 28 NEUROIMAGE 663 (2005); Phan et al., *supra* note 1; Kozel et al., *supra* note 1; Ganis et al., *supra* note 1; Nubuhito Abe et al., *Deceiving Others: Distinct Neural Responses of the Prefrontal Cortex and Amygdala in Simple Fabrication and Deception with Social Interactions*, 19 J. COGNITIVE NEUROSCIENCE 287 (2007); G.T. Monteleone et al., *Detection of Deception Using fMRI: Better than Chance, but Well Below Perfection*, 2 SOCIAL NEUROSCIENCE 1 (2008); Abe et al., *supra* note 3; Lee et al., *supra* note 3; Hakun et al., *Toward Clinical Trials of Lie Detection with fMRI*, 12 SOCIAL NEUROSCIENCE 1 (2008).

41. See, e.g., Kozel et al., *supra* note 1, at 611.

42. See fMRI Testing & Legal Admissibility, <http://www.cephoscorp.com/admissibility.htm> (last visited Feb. 18, 2009). This statement is inaccurate. Currently, while fMRI is sometimes admitted in courts to depict injury and illness, it has not been introduced to prove deception.

43. See Sean A. Spence, *Playing Devil's Advocate: The Case Against fMRI Lie Detection*, 13 LEGAL & CRIMINOLOGICAL PSYCHOLOGY 11, 13 (2008) (a few more have since been published, but the total number appears to be around twenty).

44. *Id.* at 24.

45. See Ganis et al., *supra* note 1, at 830 (noting that the results of three studies published in 2001 and 2002 “have not been consistent”).

difficult to integrate the results.”⁴⁶ Daniel Langleben candidly admitted in an early article that several critical aspects of the “neurobiology of deception” have not yet been studied, including tests that accurately model real-life situations.⁴⁷ In a more recent article, Dr. Langleben notes that the accuracy from two available laboratory datasets ranges between 76 and 90%, which is a “strong indication for more extensive testing rather than a focus of debate on whether the upper limits of this range is sufficient for court evidence.”⁴⁸ Other scholars provide additional critiques, noting that fMRI lie detection is “still in its infancy”; they argue that only limited conclusions can be drawn from the various studies done to date.⁴⁹ At the University of Akron School of Law Symposium on Neuroscience, Law & Government, Dr. Langleben quite candidly admitted that “it’s just not ready.”⁵⁰

There are numerous potential problems with drawing conclusions from the studies: The studies are small, ranging from a single person to less than thirty,⁵¹ the studies have used only healthy and primarily young subjects,⁵² there are concerns that countermeasures may be effective, as

46. Kozel, *Mock Crime*, *supra* note 40, at 220.

47. Langleben, Dattilio, & Guthei, *supra* note 38, at 360. See also Kozel, *Mock Crime*, *supra* note 40, at 231 (noting that while the mock crime employed by researchers provides a “diagnostic ability . . . greater than chance, future work is focused on improving specificity and using more realistic testing in order to enhance the utility of this technology in real-world applications”).

48. Daniel D. Langleben, *Detection of Deception with fMRI: Are We There Yet?*, 13 LEGAL & CRIMINOLOGICAL PSYCHOL. 1, 4 (2008). See also Ganis et al., *supra* note 1, at 835 (“[s]ubstantial . . . research . . . on deception paradigms and . . . analysis methods remains to be conducted before we can fully assess the potential of fMRI as a lie detection device.”).

49. Jonathan H. Marks, *Interrogational Neuroimaging in Counterterrorism: A “No-Brainer” or a Human Rights Hazard?*, 33 AM. J.L. & MED. 483, 489 (2007); accord Michael S. Pardo, *Neuroscience Evidence, Legal Culture, and Criminal Procedure*, 33 AM. J. CRIM. L. 301, 319 (2006) (noting various concerns, including that researchers admit that fMRI deception studies are just beginning and that the studies to date involve small sample size and relatively low stakes); Henry T. Greely & Judy Illes, *Neuroscience-Based Lie Detection: The Urgent Need for Regulation*, 33 AM. J.L. & MED. 377, 402 (2007) (stating it is as yet only a “promising technology,” and discussing the shortcomings of the studies). For a concise evaluation of the studies and their limitations, see generally Joseph R. Simpson, *Functional MRI Lie Detection: Too Good to be True?*, 36 J. AM. ACAD. PSYCHIATRY & L. 491 (2008).

50. Daniel Langleben, Speaker at the University of Akron Law Review Symposium: Neuroscience, Law and Government (Sept. 26, 2008), <http://www.uakron.edu/law/neuroscience/panell.php>.

51. See, e.g., *Lie Detection*, *supra* note 40, at 158 (only six male volunteers were analyzed in the study); see sources cited *supra* note 40 (all but two studies contained less than thirty participants); Hakun, *supra* note 40, at 2 (study involved one participant).

52. See, e.g., Mohamed et al., *supra* note 40, at 680 (“the experiments were performed in 11 healthy volunteers (five female and six male subjects; mean age, 28.9 years) who were screened for drug use, neurological and neuropsychiatric illness”); Phan et al., *supra* note 1, at 165 (all

they are with the polygraph,⁵³ and the studies require participants who are both compliant and honest in the execution of the test.⁵⁴ Additional concerns include the possibility of conflating correlation with causation, where the section of the brain thought to be tied to deception is tied to other thought processes as well; the variability of individual brains and wide variations in “normal”;⁵⁵ the inability to apply conclusions drawn from a group to conclusions about a given individual;⁵⁶ and the lack of “real-life” consequences in the studies. In a recent study that created a mock crime to more closely approximate real world situations, the authors stated the test might be helpful for excluding the innocent but was not very helpful in “ruling in” the guilty.⁵⁷

Most of the neuroimaging studies focus on very simple sample questions, as the very structure of scientific testing demands.⁵⁸ In order to generate usable data, the design of the tests is closely cabined. Nonetheless, using neuroimages to visualize deception in the real world may be more complicated. Will it appear as though subjects are lying when they are responding to what turns out to be a complicated question? For example, assume in a murder case the subject is asked whether he was with the victim on the night of the murder. The subject may need to ponder the question before answering, since he was with the victim in the late afternoon but not in the evening (when the victim was murdered). Since there are studies indicating that lies are associated

participants were healthy and without a history of head injury, learning disability, or neurological illness).

53. Spence et al., *supra* note 2, at 1415 (The authors admit one of the limitations to the study was the lack of data regarding the “ground truth” of the subjects’ embarrassing memories. The authors did not interview others to corroborate their stories, or ask for evidence. Therefore, the subjects could have fabricated the embarrassing stories they were asked about.)

54. See Kozel et al., *supra* note 1, at 612 (“Any subject who refuses to answer questions, randomly answers questions, moves their head, or refuses to enter the scanner would not be able to be tested.”).

55. Billick & Sullivan, *supra* note 31, at 46.

56. Ganis et al., *supra* note 1, at 835 (noting that most studies use group analyses to detect deception); Kozel et al., *supra* note 1, at 605 (noting that most studies look at deception at the group level).

57. See Kozel, *Mock Crime*, *supra* note 40, at 231 (proving that the method used to detect deception was “sensitive but suffers from low specificity on this task for whether a subject committed a mock crime, [indicating it] . . . would be helpful to ‘rule out’ a potential subject . . . but not very helpful in ‘ruling in’ a suspect . . .”). Accord Lee, *supra* note 3, at 410 (recognizing that their study “is hardly comparable to real-life situations, where the detection of intentional faked responses may result in serious consequences . . .”).

58. See, e.g., Kozel et al., *supra* note 1, at 606 (in which subjects took a ring or a watch and were then told to lie about the object they took).

with a longer lapse time between question and answer,⁵⁹ will the complication of the question confound the result if he answers “no,” since he had to expend energy to sort through the day/evening issue?

Moreover, questions arise about brain depiction differences between a lie that is well-rehearsed, as opposed to one that is either spontaneous or just an erroneous memory. A few studies have looked at some of these issues,⁶⁰ but more are needed. The studies only use subjects who are of exceptional mental and physical health. What will happen when they start testing more representative subjects, who may be psychologically impaired, use drugs or alcohol excessively, and have serious reasons to try to fool the examiners?

For now, the most that can be said is that the preliminary data are fascinating but sparse.⁶¹ While there is little doubt that fMRI works well for neural research, there are innumerable questions about the extent of what can be stated with certainty about the interpretation of the images generated. Every month reveals new discoveries about the areas of the brain that are implicated in deception studies, which in and of itself raises concerns about the underlying assumptions of brain region activity.⁶²

According to Professors Greely and Illes, whose interdisciplinary article details a number of concerns with the fMRI/deception studies, the studies “do not prove that [fMRI] . . . is currently effective as a lie detector in the real world, at any accuracy level”⁶³ Professor Moreno remarks that the techniques are not yet “specific enough to predict when a particular person is being intentionally deceptive.”⁶⁴

59. Sean A. Spence et al., *A Cognitive Neurobiological Account of Deception: Evidence from Functional Neuroimaging*, 359 PHIL. TRANSACTIONS. ROYAL. SOC. LOND. B 1755, 1760 (2004) (noting an increase in response time of lies relative to truthful responding).

60. Lee et al., *supra* note 3, at 407; Abe et al., *supra* note 3, at 2811; Ganis et al., *supra* note 1, at 831.

61. At the time of this article, there appear to be only about twenty-one published studies on the neuroimaging of deception. See *supra* note 40 for a comprehensive list of the studies published on the neuroimaging of deception.

62. Ganis et al. remark that there are not “brain regions . . . specialized for lying; rather . . . [we assume] various types of lies . . . [involve] different combinations of general-purpose cognitive processes which, as ensemble, may provide reliable neural signatures for various types of lies. Ganis et al., *supra* note 1, at 833. Recently, another study found, surprisingly, that rather than just the involvement of the inferior parietal and inferior frontal regions, the limbic system (the amygdala and the hippocampus) was activated in response to one deceptive answer. See Hakun, *supra* note 40, at 5. The study theorizes that the subject may have experienced some emotional reaction or moral dilemma related to the specific question. *Id.* at 7-8.

63. Greely & Illes, *supra* note 49, at 402 (emphasis in original).

64. MORENO, *supra* note 30, at 103.

In addition to the limitations inherent in the studies themselves, the technical process of creating neuroimages poses concerns about the conclusions generated from these images. For example, one group of commentators note in a recent article, “[a]lthough . . . [neuroimages] are described as ‘real time’ brain images, the temporal resolution of the hemodynamic response is several seconds while events relevant to information processing are at least three orders of magnitude faster.”⁶⁵ The design of studies, they note, involves statistical “analyses of comparison.”⁶⁶ Yet, none of the steps are “standardized from one technology to the next, or from one machine or laboratory to the next.”⁶⁷ Thus, the problems are not just with the design of the studies but with the technological mechanics of their implementation as well. And the briefly-described critiques are a handful of the many articles discussing limitations of fMRI to detect deception.

Finally, the neuroimaging studies use voluntary subjects who agree to be honest and compliant.⁶⁸ Without question, such requirements do not match real-world application. In sum, the studies raise as many questions as they answer.

III. “BRAIN FINGERPRINTING” AND BEOS

Research is also being conducted with electroencephalograph technology (EEG) to find neural correlates of deception. These studies are not technically neuroimages but rather graphs depicting changes in brain waves. Although it appears as though there are interesting and promising studies underway, analysis of them is beyond the scope of this article which is focusing on neuroimages.⁶⁹

65. Joseph H. Baskin, Judith G. Edersheim & Bruce H. Price, *Is a Picture Worth a Thousand Words? Neuroimaging in the Courtroom*, 33 AM. J.L. & MED. 239, 249 (2007).

66. *Id.*

67. *Id.* Other researchers note the problems of comparing results of one study to another, due to different paradigms used in each study. Phan et al., *supra* note 1, at 171 (criticizing studies that offer monetary incentive to lie).

68. See Kozel et al., *supra* note 1, at 612 (noting that the technique used “requires a cooperative subject”). While the study authors note that the test subjects were told they would be given a \$50 bonus if it could not be determined when they were lying, such incentive in no way compares to real life consequences for crime suspects. *Id.* at 606, 611. Simpson remarks that if subjects refuse to enter the scanner, refuse to respond to questions, give nonresponsive answers, or even shake their heads during the exam, the results may not be usable. Simpson, *supra* note 49, at 493.

69. See, e.g., J. Peter Rosenfeld et al., *The Complex Trial Protocol (CTP): A New, Countermeasure-resistant, Accurate, P300-based Method for Detection of Concealed Information*, 45 PSYCHOPHYSIOLOGY 906 (2008) and references cited therein.

However, since there has been an attempt to use less well-studied forms of EEG at trial in the US and in India, this article addresses them: the inaptly-named “brain fingerprinting” and the Brain Electrical Oscillation Signature test (“BEOS”). The coiner of the brain fingerprinting term, Dr. Lawrence A. Farwell, claims that the brain emits a characteristic wave response when presented with a known stimulus. Thus, when the brain recognizes something as significant in the current context in which it is presented, the brain reacts predictably. Farwell conducted an experiment in which lay persons and FBI agents were shown acronyms known only to agents. Apparently, only the agents’ brains exhibited this recognition wave.⁷⁰

In essence, the claim is that this device captures a recognition wave of the brain. Farwell claims that using EEG technology, he can detect changes in brain waves that take place over a very short period of time (approximately one second). These changes can be classified as having relevant information (knowledge) and not having such information (no knowledge). Even when the subjects were intentionally trying to conceal knowledge, Farwell claims that the test could detect accurately whether the subjects knew or did not know.⁷¹

IV. CRITICISM OF BRAIN FINGERPRINTING AND BEOS

The first concern is of course that recognition (if indeed that is what is displayed) may arise in a variety of ways—some quite innocent. Second, this test appears to misunderstand the nature of memory, which does not record and recall information like a video recorder, but layers memory over memory, changes, loses, restructures, and adapts to continual addition of new information. Every time a memory is recalled, it is altered.⁷²

70. See Lawrence A. Farwell, *Farwell Brain Fingerprinting: A New Paradigm in Criminal Investigations*, Jan. 12, 1999, at 5.5.1, <http://www.mindcontrolforums.com/bf-research.htm>; see Lawrence A. Farwell & Sharon S. Smith, *Using Brain MERMER Testing to Detect Knowledge Despite Efforts to Conceal*, 46 J. FORENSIC SCIENCE 135 (2001). Brain fingerprinting is an inapt term, since fingerprinting, a form of individualization, seeks to match an unknown sample with a known sample. Brain fingerprinting does not involve any form of attempted individualized matching. Rather, the term was likely chosen to draw on the supposed trustworthiness of fingerprinting comparison. The early uses of DNA as a method of individualization often used the term “genetic fingerprinting”—a more apt use of the concept. See SIMON A. COLE, *SUSPECT IDENTITIES: A HISTORY OF FINGERPRINTING AND CRIMINAL IDENTIFICATION* 289 (2001) (discussing the use of the term “genetic fingerprinting” with reference to DNA profiling).

71. Farwell & Smith, *supra* note 70, at 141.

72. See Ornstein, Ceci, & Loftus, *supra* note 5, at 1029-30.

Scholars have leveled serious criticism at Farwell,⁷³ going so far as to label him “notorious” for the claims he has made.⁷⁴ Other scholars note that “Farwell’s claims are widely discounted in the relevant scientific community”⁷⁵ There is little research—other than Farwell’s—to back up his claims, and he apparently refuses to allow others to review his algorithms, claiming his technique is proprietary.⁷⁶ Dr. J. Peter Rosenfeld of Northwestern University, one of the early scientists involved with EEG-based deception testing with Farwell, has written an in-depth critique of the technical shortcoming of Brain Fingerprinting, detailing the misleading nature of Farwell’s claims.⁷⁷

The BEOS test allegedly builds on Farwell’s work, and it has been admitted in court in India. The inventors claim that the system can distinguish between memories of events witnessed and deeds that have been committed.⁷⁸ Like Farwell’s work, the BEOS test has met with much skepticism, despite its recent use in Indian courts. Dr. Rosenfeld accurately notes that such technology, which is “neither seriously peer-reviewed nor independently replicated, [is] not . . . credible.”⁷⁹ Dr. Michael Gazzaniga, director of the MacArthur Law & Science Project,⁸⁰ is likewise dismissive of BEOS, stating that “[a]ll the experts agree. The work is shaky at best.”⁸¹

A further question about the validity and reliability of both fMRI and EEG images of deception concerns the financial stakes involved in the neuroimaging of deception. Even if one assumes the scientists are acting in good faith, the race to the courthouse has financial implications that should be considered in the evaluation of such science,⁸² a point recognized in the remand of the well-known *Daubert* opinion.⁸³

73. See Sara Solovitch, *Mind Reader*, LEGAL AFFAIRS, Nov.-Dec. 2004, at 66-67 (noting that “many scientists accuse Farwell of making misleading and exaggerated claims”).

74. MORENO, *supra* note 30, at 104.

75. Greely and Iles, *supra* note 49, at 388.

76. Solovitch, *supra* note 73, at 70.

77. See J. Peter Rosenfeld, “Brain Fingerprinting”: A Critical Analysis, 4 SCI. REV. OF MENTAL HEALTH PRAC. 20, 20 (2005).

78. See Anand Giridharadas, *India’s Novel Use of Brain Scans in Courts is Debated*, N.Y. TIMES, Sept. 15, 2008, at A10.

79. *Id.*

80. See Governance, <http://www.lawandneuroscienceproject.org/governance.php> (last visited Feb. 18, 2009).

81. Giridharadas, *supra* note 78.

82. See JAY D. ARONSON, GENETIC WITNESS: SCIENCE, LAW AND CONTROVERSY IN THE MAKING OF DNA PROFILING 5-6 (2007) (discussing Cellmark and Lifecodes’ quest to become the dominant DNA Profiling company in the United States and the errors discovered in their methods long after much DNA evidence was admitted). Accord COLE, *supra* note 70, at 287-302 (2001) (discussing the early development of DNA profiling and explaining some of the problems

These foregoing critiques do not imply that the science is not promising; it just may be promising more than it can deliver at this point in time. It is wiser, I believe, to spend more time in the lab than to rush the science to the courtroom where, after destroying lives, we have discovered that, indeed, there was more work to be done.

V. ADMISSIBILITY STANDARDS: RELIABILITY AND GENERAL ACCEPTANCE

No reported case has yet to admit fMRI evidence at trial as proof of deception (or lack of deception), but it seems likely that advocates will attempt to convince courts to do so in the relatively near future, particularly in light of the claims made by companies hoping to be the first to open the courthouse doors. Since the evidence is novel and serves the same evidentiary purpose as the polygraph, I would expect most courts to be hesitant in admitting such evidence. But perhaps it will not be that straightforward. If history has taught us anything about forensic science in criminal cases (which are the most likely cases in which this evidence would be admitted), the rule has been to admit prosecutorial expert testimony and exclude defense uses of such evidence.⁸⁴

For this neuroimaging evidence to be admissible, the advocate of such evidence must be able, depending on the jurisdiction, to convince a trial court that this proposed expert evidence is either scientifically reliable⁸⁵ or that the scientific theory at issue is generally accepted

associated with the commercial laboratories). Both Cephos and No Lie MRI are commercial ventures designed to capitalize on fMRI research, as is Farwell's Brain Fingerprinting company. For further details on these companies, see Moriarty, *supra* note 36, at 33-34.

83. That an expert testifies for money does not necessarily cast doubt on the reliability of his testimony, as few experts appear in court merely as an eleemosynary gesture. But in determining whether proposed expert testimony amounts to good science, we may not ignore the fact that a scientist's normal workplace is the lab or the field, not the courtroom or the lawyer's office.

Daubert v. Merrell Dow Pharm., Inc., 43 F.3d 1311, 1317 (9th Cir. 1995). Despite recognizing the importance of finances in expert testimony, Judge Kozinski exempts forensic science from this inquiry. "Fingerprint analysis, voice recognition, DNA fingerprinting, and a variety of other scientific endeavors closely tied to law enforcement may indeed have the courtroom as a principal theatre of operations." *Id.* at 1317 n.5. In another article, I have challenged this distinction. See Moriarty, *supra* note 7, at 39-42.

84. See NAS REPORT ON FORENSIC SCIENCE, *supra* note 10, at 3-9 to 3-11. Moreover, in *United States v. Scheffer*, where the Court remarked that there was no consensus on polygraph reliability, it was the defendant who was seeking to admit such evidence. 523 U.S. 303, 306 (1998).

85. See, e.g., FED. R. OF EVID. 702 (providing, in pertinent part, that an expert may testify if "(1) the testimony is based upon sufficient facts or data, (2) the testimony is the product of reliable principles and methods, and (3) the witness has applied the principles and methods reliably to the

within the field.⁸⁶ Despite the claims of those attempting to market the neuroimaging of deception, it should be beyond cavil at this point in time that neuroimages of deception satisfy neither of these tests. Even if elemental questions concerning deception can be accurately visualized on a neuroimage with a cooperating subject, there is too great an analytic gap from data generated to conclusions about whether a particular person is deceptive to satisfy any standard of legal admissibility.

The United States Supreme Court has held that the Federal Rules of Evidence (“FRE”) “occupy the field” in federal courts; that is to say, the Rules provide the primary source of law for the federal judiciary in deciding whether evidence should be admitted.⁸⁷ In 2000, FRE 702, governing the admission of expert testimony, adopted a reliability standard in which the proposed testimony must be based on sufficient facts or data, must be the product of reliable principles and methods, and the witness testifying must have applied such principles and methods in a reliable fashion to the facts of the case.⁸⁸

FRE 702 is an attempt to distill the requirements of the Supreme Court’s trilogy of cases that govern the admission of expert evidence.⁸⁹ Collectively, these cases (and the amended FRE 702) exhibit a concern not just about whether the evidence is generally reliable but about whether evidence is reliable as used in a given case. “[R]eliability cannot be judged globally, ‘as drafted,’ but only specifically, ‘as applied.’ The emphasis [is] on the judgment of reliability as it applies to

facts of the case”). *Accord* *Daubert v. Merrell Dow Pharm., Inc.*, 509 U.S. 579, 590 (1993); *General Elec. Co. v. Joiner*, 522 U.S. 136, 144-45 (1997); *Kumho Tire Co. v. Carmichael*, 526 U.S. 137, 141 (1999) (requiring sufficient proof that the proposed expert evidence is sufficiently reliable to be admitted).

86. While the foregoing federal reliability standard is used in many states, other states follow the so-called “general acceptance” standard, which originated in *Frye v. United States*, 293 F. 1013, 1014 (D.C. Cir. 1923); *see, e.g.*, *Grady v. Frito-Lay, Inc.*, 839 A.2d 1038, 1045 (Pa. 2003) (holding that an expert’s methodology must be generally accepted); *Logerquist v. McVey*, 1 P.3d 113, 122 (Ariz. 2000) (holding that the general acceptance test applies to novel scientific evidence).

87. *Daubert*, 509 U.S. at 587.

88. Federal Rule of Evidence 702, entitled “Testimony By Experts,” provides that: If scientific, technical, or other specialized knowledge will assist the trier of fact to understand the evidence or to determine a fact in issue, a witness qualified as an expert by knowledge, skill, experience, training, or education, may testify thereto in the form of an opinion or otherwise, if (1) the testimony is based upon sufficient facts or data, (2) the testimony is the product of reliable principles and methods, and (3) the witness has applied the principles and methods reliably to the facts of the case.

FED. R. EVID. 702.

89. *See* FED. R. EVID. 702 advisory committee note (“Rule 702 has been amended in response to *Daubert* . . . and the many cases applying *Daubert* . . .”). *Daubert v. Merrell Dow Pharm., Inc.*, 509 U.S. 579 (1993); *General Elec. Co. v. Joiner*, 522 U.S. 136 (1997); *Kumho Tire Co. v. Carmichael*, 526 U.S. 137 (1999).

the individual case, to the ‘task at hand’⁹⁰ Thus, while an x-ray may be reliable evidence of a skull fracture, it might not be reliable evidence to support the expert’s claim that a given defendant was legally insane at the time he committed a homicide. It is not that the x-ray itself is an unreliable bit of evidence; it is that the interpretation of such evidence may lack evidentiary reliability. The interpretation of the image is what rests on a less-than-solid foundation.

Daubert, and cases following, envision a flexible standard, in which the trial court, as gatekeeper of the evidence, determines whether expert evidence meets the minimal standard of evidentiary reliability. If it does, the evidence is admissible and any shortcomings in the evidence go to weight, not admissibility. In determining whether evidence meets the standard of evidentiary reliability, the *Daubert* Court (and innumerable cases since) focused on several “observations” that the Court deemed helpful in determining evidentiary reliability: (1) whether the theory or technique can be or has been tested, (2) whether the theory or technique has been subjected to peer review and publication, (3) the potential or known rate of error of the theory or technique when applied, (4) the existence and maintenance of standards controlling the technique’s operation, and (5) whether the technique or theory has been generally accepted in the relevant scientific community.⁹¹ This flexible standard for expert testimony was premised on the idea of “evidentiary reliability” or “trustworthiness.” Rather than wholesale exclusion, *Daubert* opined that “[v]igorous cross-examination, presentation of contrary evidence, and careful instruction on the burden of proof,” coupled with the court’s power to direct verdicts and grant summary judgment, were the “appropriate means of attacking shaky but admissible evidence.”⁹² One difficulty *Daubert* poses, of course, is determining the proper line that separates “shaky but admissible” from “unreliable thus inadmissible.”

The *Daubert* Court limited the trial court’s focus on reliability to the methodology employed, not the conclusions generated.⁹³ In one of the subsequent trilogy of cases the Supreme Court decided, *General Electric Co. v. Joiner*,⁹⁴ the Court softened the line between methodology and conclusions, stating that

90. D. Michael Risinger, *Defining the “Task At Hand”: Non-Science Forensic Science after Kumho Tire Co. v. Carmichael*, 57 WASH. & LEE L. REV. 767, 773 (2000).

91. *Daubert*, 509 U.S. at 592-94.

92. *Id.* at 596.

93. *Id.* at 595.

94. 522 U.S. 136 (1997).

conclusions and methodology are not entirely distinct from one another. Trained experts commonly extrapolate from existing data. But nothing in either *Daubert* or the Federal Rules of Evidence requires a district court to admit opinion evidence that is connected to existing data only by the *ipse dixit* of the expert. A court may conclude that there is simply too great an analytical gap between the data and the opinion proffered.⁹⁵

The recognition that there may be “simply too great an analytic gap between the data and opinion proffered” is one that is particularly apt in analyzing the legal admissibility of neuroimages of deception.

In the final case of the trilogy, *Kumho Tire v. Carmichael*, the Court described the discretion the trial court had in determining whether and how these factors should be considered by the trial court:

We . . . conclude that a trial court may consider one or more of the more specific factors that *Daubert* mentioned when doing so will help determine that testimony’s reliability. But . . . the test of reliability is “flexible,” and . . . the law grants a district court the same broad latitude when it decides how to determine reliability as it enjoys in respect to its ultimate reliability determination.⁹⁶

Although the trilogy embraces a flexible standard, the language of *Kumho Tire* provides an important recommendation: “[A] trial court should consider the specific factors identified in *Daubert* where they are reasonable measures of the reliability of expert testimony.”⁹⁷ The factors provide reasonable measures of the reliability of neuroimaging evidence.

Not all jurisdictions, however, use a reliability standard. Rather, a number of courts still use the so-called “general acceptance” test, which emanates from a 1923 D.C. Court of Appeals decision holding that the precursor to the polygraph had not yet reached a state of scientific general acceptance required to be admissible.⁹⁸ The *Frye* test does not analyze the reliability of the proposed evidence; it asks whether novel scientific evidence has reached the tipping point at which it has become generally accepted by scientists in the field.

For many decades after the original decision, the *Frye* test was mentioned infrequently, but during the 1970s and 1980s, it became the “the icon for one of the dominant notions of the proper criterion for the

95. *Id.* at 146.

96. 526 U.S. 137, 141 (1999).

97. *Id.* at 152.

98. *Frye v. United States*, 293 F. 1013, 1014 (D.C. Cir. 1923).

admissibility of scientific evidence—general acceptance within its field.”⁹⁹

In theory, the test is a fairly straightforward one for the courts—it simply requires courts to determine whether the proponent of the evidence has established that a novel theory is accepted in the scientific arena. In practice, however, *Frye* is a more complicated inquiry and a standard that has been criticized on various grounds, including its failure to mesh well with a scientific inquiry.¹⁰⁰

Although the federal courts do not follow the *Frye* general acceptance standard, a sizeable minority of states continue to do so.¹⁰¹ Moreover, while the federal courts follow a reliability standard, general acceptance often plays a role in admissibility decisions.

VI. WHY fMRI, BRAIN FINGERPRINTING, AND BEOS IMAGES OF DECEPTION MEET NEITHER THE RELIABILITY NOR GENERAL ACCEPTANCE STANDARDS

The problems with the forensic use of brain fingerprinting and BEOS to detect deception are legion, as discussed above. Moreover, given the roundly critical commentary about these forms of evidence, there is no real argument that scientists in that particular field generally accept the theory that brain fingerprinting or BEOS can accurately indicate when a subject is telling the truth or lying.

Scientists are creating a fascinating body of work using fMRI to depict neural correlates of deception. These neuroscientists are beginning to sketch a portrait of the ways the brain works and the areas of the brain that are implicated when a subject attempts to deceive or fails to remember accurately. Sketch, however, may be the operative word. The studies are just beginning; there are numerous questions unanswered and numerous areas to be developed. What does not exist is sufficient proof that neuroimages can accurately prove when an individual is lying and when she is telling the truth.

99. David L. Faigman, Elise Porter & Michael J. Saks, *Check Your Crystal Ball at the Courthouse Door, Please: Exploring the Past, Understanding the Present, and Worrying About the Future of Scientific Evidence*, 15 CARDOZO L. REV. 1799, 1808 (1994).

100. See, e.g., *United States v. Downing*, 753 F.2d 1224, 1236-37 (3d Cir. 1985) (discussing criticisms of *Frye*); Paul C. Giannelli, *The Admissibility of Novel Scientific Evidence: Frye v. United States a Half-Century Later*, 80 COLUM. L. REV. 1197, 1211-12 (1980) (discussing, *inter alia*, criticisms of *Frye*).

101. See 2 JANE CAMPBELL MORIARTY, *PSYCHOLOGICAL AND SCIENTIFIC EVIDENCE IN CRIMINAL TRIALS* at app. 1A (2008) (providing a state-by-state analysis of admissibility standards).

Taking *Daubert's* factors seriously, while the scientists can show that the subject can be tested and that there is developing an accuracy rate of somewhere between seventy-five and ninety percent, as published in peer-reviewed journals, there is still a very long way to go before such an error rate is within acceptable limits. Moreover, while some scientists working on neuroimaging and deception studies might claim these studies are solid proof, there are other, more critical studies from disinterested scholars about shortcomings in the methods and standards. When even Dr. Langleben, one of the first neuroscientists to depict neuroimages related to deception, says the science is not ready, courts should, indeed must, listen. To date, those who advocate for the admission of such evidence are only those with a financial stake in the admissibility of such evidence.¹⁰²

There is a small number of studies; all of these studies have substantial shortcomings that do not allow realistic application of the data generated to real-world conclusions about an individual; there are complicated problems of differing formats, technology, and testing methods; the studies have tested few people, all of whom are healthy; and so on. While fMRI may indicate what areas of the brain are implicated in deception, we will need to know what else those areas of the brain indicate before any meaningful conclusions can be drawn.

Moreover, while there are several peer-reviewed studies, the purpose of the peer review system has not yet been met with neuroimaging: to allow other scientists to attempt to replicate the results and to engage in critical analysis of others' conclusions. "Research science is all about replication and rival interpretations."¹⁰³ Given that the science is in its infancy, we should expect much more in the way of robust criticism from various sources before we decide the evidence is sufficiently trustworthy for the courtroom.

As outlined above, the most substantial question is the appropriate inference that can be drawn from the image projected. It is, to use the parlance of *Joiner*, the "*ipse dixit*" problem; the gap between the existing data and the opinion about the meaning of such data. And that is a wide gap indeed at this point in time.¹⁰⁴

102. See *Harrington v. State*, 659 N.W. 2d 509, 512 (Iowa 2003); Farwell, *supra* note 70, at 1.1.14; *Our Business is the Truth*, <http://www.cephoscorp.com/index.htm> (last visited Mar. 6, 2009).

103. See Roger Koppl, Presentation at Forensic Science for the 21st Century: The National Academy of Sciences' Report and Beyond, Sandra Day O'Connor College of Law, Arizona State University (Apr. 4, 2009), <http://lst.law.asu.edu/FS09/index.html>.

104. History provides a lesson here. As Professor Moenssens cogently states:

There are other questions, of course, that do not specifically relate to admissibility standards and that relate to this continual quest, from the Salem witchcraft trials forward, to find the proper way to extract “truth” for purposes of proof. It is a question beyond the narrow scope of this article but is at the heart of any attempt to introduce this type of evidence in a courtroom.

There is a unique opportunity here with the fMRI neuroimaging of deception that has been missed with other forms of expert evidence introduced in criminal trials: the science is developing outside of the courtroom in multiple, competing laboratories that are testing different aspects of the scientific endeavor. While one group works on mapping specific areas of the brain that seem to be implicated with deceptive answers, other groups are considering what parts of the brain are involved when there is emotional arousal entwined with the memory of the event. The science is developing and, to date, it has not really entered the courtroom.¹⁰⁵ The critics are also publishing articles, leading to a more balanced picture of the limitations of the science.

By comparison, most forensic science was developed specifically to aid the criminal justice system and was “grandfathered” into the courtroom as reliable—without serious proof of validity or reliability.¹⁰⁶ Most recently, in the National Academy of Sciences’ scathing report on the shortcomings of forensic science, they found that much forensic science evidence has been admitted in criminal trials “without any meaningful scientific validation, determination of error rates, or reliability testing to explain the limits of the discipline.”¹⁰⁷ Admitting evidence first and asking questions later (if ever) is the evidentiary

But the longer one observes the disciplines of the forensic sciences, the more one has to deal with strongly conflicting emotions. On the one hand, one admires the truly revolutionary new methods that have been and are being developed. On the other hand, one remembers some horror stories of the past when too much haste in rushing new methods through the evidentiary hoops resulted in convictions on less than sound scientific bases. I urge caution because its absence is the antithesis of the scientific method; lack of caution leads to grievous error that tends to bring forensic science into disrepute.

Andre A. Moenssens, *Novel Scientific Evidence in Criminal Cases: Some Words of Caution*, 84 J. CRIM. L. & CRIMINOLOGY 1, 4-5 (1993).

105. There is one exception in which a trial court admitted Farwell’s brain fingerprinting evidence in a hearing, although it declined to discuss its value in the opinion, nor did it rely on such evidence when reaching its opinion. See *Harrington*, 659 N.W.2d at 512.

106. See generally COLE, *supra* note 70 (discussing, *inter alia*, the history of admissibility of fingerprint comparison); Jane Campbell Moriarty & Michael J. Saks, *Forensic Science: Grand Goals, Tragic Flaws & Judicial Gatekeeping*, 44 A.B.A. JUDGES’ J. 16, 28 (2005) (discussing the ready admissibility of prosecutorial forensic science evidence).

107. NAS FORENSIC SCIENCE REPORT, *supra* note 10, at 3-18.

pattern that most forensic science has followed, and it is a flawed and problematic approach for new and developing scientific evidence. Both with fMRI and DNA evidence, the science is complex and has powerful potential to profoundly affect the outcomes in cases.¹⁰⁸

In the case of DNA profiling evidence, the most science-based and reliable form of individualization evidence (which attempts to match a known sample to a crime scene, victim, or defendant), no serious challenge was raised to the evidence for several years after it was first admitted.¹⁰⁹

There is a chance, however, to do things differently with fMRI evidence of deception. I would urge an informal evidentiary moratorium on admission of this evidence unless and until the science has developed to a place where: (1) the scientists and their critics reach consensus that the results are truly valid, reliable, reproducible, accurate, and the error rate is within an acceptable margin of error; (2) the potential confounding problems related to sample size, group versus individual determinations, and the potential problems of correlation versus causation have been sorted out; and perhaps most importantly, (3) there has been time for sufficient moral, ethical, and jurisprudential rumination about whether the legal system really wants this type of evidence.¹¹⁰ This delay provides time for additional peer review, replication of results, robust disagreements, and discovery of unanticipated consequences that might arise from this new, fascinating, and challenging scientific endeavor.

108. *See id.*

109. *See* ARONSON, *supra* note 82, at 7.

110. For more on this subject, see, *e.g.*, Michael S. Pardo and Dennis Patterson, *Philosophic Foundations of Law and Neuroscience*, posted on SSRN.com at <http://ssrn.com/abstract=1338763>.

