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The Future of Neuroimaged Lie Detection and the Law

Joelle Anne Moreno

THE FUTURE OF NEUROIMAGED LIE DETECTION AND THE LAW

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News broke during the last week of September 2008 that the Department of Homeland Security has begun testing a new mind-reading device.[1] According to the Department's website, the Human Factors Directorate of Science and Technology has been working on Future Attribute Screening Technology (FAST).[2] Homeland Security defines FAST as

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1. Thomas Frank, *Anxiety Detecting Machines Could Spot Terrorists*, USA TODAY, Sept. 18, 2008; Allison Barrie, *Homeland Security Detects Terrorist Threats by Reading Your Mind*, Fox News.com, Sept. 23, 2008 http://www.foxnews.com/story/0,2933,426485,00.html.

2. Dept. of Homeland Security: Science and Technology Directorate Human Factors Behavioral Sciences Division. http://www.dhs.gov/xres/programs/gc_1218480185439.shtm#9 (last visited Feb. 23, 2009).

> an initiative to develop innovative, non-invasive technologies to screen people at security checkpoints. FAST is grounded in research on human behavior and psychophysiology, focusing on new advances in behavioral/human-centered screening techniques. The aim is a prototypical mobile suite (FAST M2) that would be used to increase the accuracy and validity of identifying persons with malintent (the intent or desire to cause harm).[3]

Although design specifics have not been made public, the MALINTENT prototype is a device that rapidly and remotely measures subjects' body temperature, heart rate, and respiration.[4] MALINTENT then compares these measurements with a matrix of physiological norms to generate conclusions about each subject's future dangerousness. MALINTENT's designers and proponents believe that this new technology will reliably distinguish perspiring perambulators and fearful flyers from true terrorists.[5] These claims are difficult to assess because the results of the only publically disclosed tests of MALINTENT were subsequently classified.[6]

The creation of the MALINTENT prototype signals that we are fast approaching a future of increased reliance on technologically sophisticated devices that purport to reveal cognition and predict behavior. These and other new "mind-reading" machines will have a profound impact on society and law. Those worried about the risks of these new devices will likely find cold comfort in the assurances of Homeland Security Department project leader Bob Burns that fully-operational MALINTENT-screened security checkpoints will "restore a sense of freedom" to America.[7]

I learned about MALINTENT shortly after I had returned from the University of Akron School of Law symposium on *Neuroscience, Law and Government*. On a lovely fall day in late September 2008, Professor Jane Moriarty assembled an impressive group of legal scholars, judges, and scientists and asked them to embark on a far-ranging discussion of the potential points of intersection between neuroscience and law (a field sometimes referred to in the popular press – although not once at this

3. Thomas Frank, *Anxiety Detecting Machines Could Spot Terrorists*, USA TODAY, Sept. 18, 2008; Allison Barrie, *Homeland Security Detects Terrorist Threats by Reading Your Mind*, Fox News.com, Sept. 23, 2008 http://www.foxnews.com/story/0,2933,426485,00.html.

4. Barrie, *supra* note 1.

5. Barrie, *supra* note 1 ("If you're rushed or stressed, you may send out signals of anxiety, but FAST isn't fooled. It's already good enough to tell the difference between a harried traveler and a terrorist. Even if you sweat heavily by nature, FAST won't mistake you for a baddie.").

6. *Id.*

7. Barrie, *supra* note 1.

symposium – as “neurolaw”).[8] We did not know about the MALINTENT prototype when we met in Akron, but many of us focused on current and future efforts to measure and correlate peripheral nervous system responses with cognition.

New technologies designed for “mind-reading” are our future. They will likely include *both* cost-effective remote MALINTENT-style dangerousness detectors (for use outside the courtroom) and new efforts to map the neural correlates of deception and social behavior (for use outside *and* inside the courtroom). In the very near future, legal scholars, judges, and practitioners will need to decide when law and society can legitimately rely on cognitive neuroscience and other forms of “mind-reading” research. Under the circumstances, I was delighted that Professor Moriarty invited me to join this discussion and contribute this Article to the *Akron Law Review*.

Although neuroscience and neuroimaging technologies are in a dynamic state of rapid improvement, I will begin with a few basics. Neuroscience is the study of the brain and nervous system. The three neuroimaging technologies/modalities most frequently used to measure brain activity are: functional magnetic resonance imaging (fMRI), electroencephalography (EEG), and positron emission tomography (PET).[9] fMRI uses an MRI scanner to measure active brain blood flow, EEG uses electrodes attached to the scalp to measure electrical activity, and PET measures the absorption of small amounts of radioactive materials introduced into the subject’s body. All three neuroimaging technologies were developed for medical diagnostic purposes and continue to be used for these purposes.[10] For example, fMRI images are frequently used for neurosurgical planning, EEGs for the evaluation of

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8. *See* The University of Akron: Neuroscience, Law and Government Symposium – Program Videos [hereinafter, Neuroscience Symposium], http://www.uakron.edu/law/neurosymposium.php (last visited Feb. 22, 2009).

9. An important distinction between fMRI and EEG is that fMRI provides a more precise image of the location of neural activity than EEG, but is an inferior measure of neural change because fMRI images are generally taken every two seconds and EEGs use a millisecond scale to measure electrical impulses. *See* Robin Marantz Henig, Looking for the Lie, N.Y. TIMES, Feb. 5, 2006. During his presentation, Dr. Daniel Langleben also described a recent series of Japanese PET scan studies. *See* Neuroscience Symposium, http://www.uakron.edu/law/neuroscience/panel1.php. He noted that despite the superior quality of the images generated by PET scan, these studies would not be replicated by any U.S. researchers because PET scans involve a high level of radiation and some amount of pain (due to the placement of an intravenous line). *Id.*

10. Eric Racine, et al., *fMRI in the Public Eye*, 6 NAT. REV. NEUROSCIENCE 159, 159 (2005) (describing how fMRI and PET have “evolved as key research approaches to studying both disease processes and the basic physiology of cognitive phenomena in contemporary neuroscience”).

seizures, and PET scans to monitor the progress of cancer treatment.[11] The field of cognitive neuroscience barely existed ten years ago;[12] but neuroscientists have become increasingly interested in exploring the possibility that these same neuroimaging technologies can accurately correlate brain activity with cognition.

Even more recently, cognitive neuroscience, "neuroethics," and even "neuropolitics" and "neuromarketing" have gone mainstream.[13] Neuroethics, a term commonly credited to the New York Times columnist William Safire,[14] is generally used to describe the constellation of normative and social issues implicated by decisions on how society should use neuroscientific data.

I am writing this Article at the tail end of a prolonged and fractious election cycle. Thus, it is also worth nothing that the 2008 presidential election marked the birth of a new field of neuroethics that might be called "neuropolitics." For example, just one week before the election, the *New York Times* published an op-ed by neuroscientists from Princeton and the University of Pennsylvania asserting that

> [r]ecent research in neuroscience and psychology . . . suggests that most undecided voters may be smarter than you think. They're not indifferent or unable to make clear comparisons between the candidates. They may be more willing than others to take their time — or else just unaware that they have essentially already made a choice.[15]

These authors make relatively modest claims.[16] However, an earlier N.Y.U. neuropolitics study concluded that brain scans of subjects who identified themselves as "liberal" demonstrate more anterior cingulate

11. *See* Columbia University Medical Center: Program for Imaging and Cognitive Sciences, The Future Role of functional MRI in Medical Applications, http://www.fmri.org/fmri.htm (describing the potential uses of fMRI technology in neurosurgical planning); Lee, Sang-Ahm, et al., *Intracranial EEG Seizure-Onset Patterns in Neocortical Epilepsy*, 41(3) EPILEPSIA 297 (2000) (reporting the results of a study using EEGs to analyze the onset of epileptic seizures), *available at* http://www3.interscience.wiley.com/cgi-bin/fulltext/119003501/PDFSTART); *Specter Says His Cancer has Returned*, WASH. POST, Apr. 16, 2008, at A05 (routine PET scan revealed that Pennsylvania Senator Arlen Specter's cancer had returned).

12. Edward Vul et al, *Puzzlingly High Correlations in fMRI Studies of Emotion, Personality, and Social Cognition*, PERSPECTIVES ON PHYSIOLOGICAL SCIENCE (forthcoming May 2009) (noting that efforts to correlate social behavior to brain activity began approximately ten years ago).

13. Racine, *supra* note 10 at abstract (noting that the wide dissemination of cognitive neuroscience research has "not escaped the attention of the neuroscience and neuroethics communities, the media or the broader public").

14. A September 28, 2008 search of the New York Times website reveals that the term "neuroethics" first appeared in a May 16, 2002 Safire column entitled *The But-What-If Factor*. William Safire, *The But-What-if Factor*, N.Y. TIMES, May 16, 2002.

15. Sam Wang & Joshua Gold, *Your Brain's Secret Ballot*, N.Y. TIMES, Oct. 28, 2008.

16. *Id.*

cortex activity than those who identified themselves as "conservative." According to the N.Y.U. psychologists, enhanced brain activity among the liberal cohort correlates with a heightened sensitivity to the need for change.[17] A third widely-read (and widely-criticized) neuropolitics study from U.C.L.A. reported that brain scans of subjects who were shown pictures of presidential candidates or the words "Democrat," "Republican," and "Independent" revealed neural activity that correlated with emotions that included disgust, anxiety, ambivalence, and empathy.[18] With the election just days away and the holiday season fast approaching, this neuropolitics research was replaced in the mainstream media with even more recent "neuromarketing" efforts to use EEGs to gauge shoppers' purchasing preferences.[19]

All of this neuroscience in the news suggests that if we want to predict or control future social and legal responses to cognitive neuroscience research, we must carefully consider two basic preexisting realities: (1) our shared assumptions about the validity of the medical field of neuroscience and the accuracy of diagnostic neuroimaging technologies; and (2) our increasingly frequent exposure (even within the mainstream media) to uncritical reports of cognitive neuroscience research that purports to correlate brain activity with cognition, deception, or social behavior. In general, judges, jurors, and the general public will likely view neuroscience-based evidence as legitimate "hard" science because researchers rely on technologically sophisticated neuroimaging tools of demonstrated accuracy. Thus, neuroscience research is less likely to face the inherent skepticism reserved (often appropriately) for the "soft" sciences, the forensic science, or other fields of inquiry developed solely or primarily for litigation purposes.

More specifically, the advent of nascent fields such as "neuropolitics" and "neuromarketing," reveal the growing public appetite for cognitive neuroscience research. We like to know how we

17. Nikhil Swaminathan, *Are We Predisposed to Political Beliefs?*, SCI. AM., Sept. 10, 2007, http://www.sciam.com/article.cfm?id=are-we-predisposed-to-political-beliefs.

18. Marco Iacoboni et al., *This is Your Brain on Politics*, N.Y. TIMES, Nov. 11, 2007. However, this study was severely criticized by others in the field, including neuropsychologist Martha Farah, whose response to the Iacoboni study included the following comments:

> So why do I doubt the conclusions reported in today's Op Ed piece? The problems I see have less to do with brain imaging per se than with the human tendency to make up "just so" stories and then believe them. The scattered spots of activation in a brain image can be like tea leaves in the bottom of a cup – ambiguous and accommodating of a large number of possible interpretations.

http://www.mindhacks.com/blog/2007/11/election_brain_scan_.html.

19. Tim Harford, *Money on the Brain: What Can "Neuroeconomics" Teach Us About How We Shop?*, Slate.com, Nov. 1, 2008, *available at* http://www.slate.com/id/2203159/.

think and the expanding number of neuro-fields, reveals an intense public interest in research that purports to use "brain scans" to explain psychological phenomena.[20]

Thus, future social and legal responses to cognitive neuroscience will be shaped by both our familiarity and our desires. Because these two preexisting conditions have received relatively little attention from legal scholars anxious to be the first to map a brave new world of accurately neuroimaged cognition, they will be the focus of this Article.

I. HOW SHOULD LAW PREPARE TO RESPOND TO COGNITIVE NEUROSCIENCE?

A. The Potential Influence of Cognitive Neuroscience on Law

Neuroscience will certainly change law. In fact, neuroscience research has the potential to influence a vast range of legal decisions. To the extent that neuroscientists increasingly make claims that neuroimaging reveals cognition, even the most unimaginative prognosticator might predict: (1) the preliminary investigative use of neuroimages to enhance witness interviews and police interrogations (including but not limited to lie-detection), (2) jury selection based on neuroimages that appear to reveal jurors' unconscious stereotypes or biases, and (3) arguments about intent or sentencing based on neuroimage-enhanced explanations of behavior and predictions of dangerousness.

Professor Hank Greely has cautioned that generating (even accurate) predictions about the many ways that neuroscience might impact law is an inadequate conceptual construct.[21] In addition to the obvious concern that neuroscience data be demonstrably valid, Professor Greely suggests that the legal system must also consider the potential consequences of grounding legal decisions in neuroscientific findings including questions of fairness (when neuroscience purports to predict

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20. *See* David P. McCabe & Alan Castel, *Seeing is Believing: The Effect of Brain Images on Judgments of Scientific Reasoning*, 107 COGNITION 343, 349-351 (2008) (concluding that the inclusion of brain images enhanced the perceived credibility of cognitive neuroscience research), Deena Skolnick Weisberg, et al., *The Seductive Allure of Neuroscience Explanations*, 20 J. COG. NEUROSCIENCE 470 (2008) (concluding that reference to (even irrelevant) neuroscience information interferes with subjects' ability to accurately gauge the quality of explanations of psychological explanation).

21. Henry T. Greely, THE SOCIAL CONSEQUENCES OF ADVANCES IN NEUROSCIENCE: LEGAL PROBLEMS, LEGAL PERSPECTIVES *in* NEUROETHICS: DEFINING THE ISSUES IN THEORY, PRACTICE AND POLICY, 247-48 (Oxford University Press 2005) (describing the many relevant factors that the legal system must consider to respond to neuroscience data).

behavior) and efficacy (when we seek to impose barriers and limitations on the use of neuroscience both outside and inside the courts).[22] These concerns are implicated by anticipated legal and extralegal reliance on current and future cognitive neuroscience research.

B. Neuroimages in Court

Neuroscience evidence is often admitted in court. In fact, MRIs are routinely admitted even when they are relevant to behavior. For example, last summer in a criminal case that attracted national media attention, a Manhattan jury viewed MRI brain scans of local celebrity defendant Peter Braustein.[23] Braustein, a well-known former journalist, was charged with the kidnapping, sexual abuse, and robbery of a former colleague. The jury viewed Braustein's MRI scans and heard defense arguments linking Braustein's schizophrenia to his inability to control his violent impulses.[24] This jury presumably considered the possibility that brain scans might provide reasonable doubt that Braustein had formulated the requisite intent to harm this victim. However, they were not convinced and the defendant was convicted on all counts.[25] The Braustein case, because it involved MRI evidence to explain the defendant's actions, is representative of the type of behavior-related neuroscience evidence that is increasingly likely to be proffered and admitted in both criminal and civil trials.

C. Cognitive Neuroscience Evidence in Court

Cognitive neuroscience has yet to enter U.S. courts.[26] However, in June 2008, in a courtroom in Pune, India, evidence derived from a Brain Electrical Oscillations Signature ("BEOS") test was admitted during the murder trial of Aditi Sharma.[27] During pre-trial police interrogation of

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22. *Id.*

23. David B. Caruso, *Experts Study Neuroscience Use in Courts*, WASH. POST, Mar. 2, 2008.

24. *Id.*

25. *Id.*

26. However, in September the *International Herald Tribune* reported on a June 2008 murder trial in Maharashtra, India where the court found that evidence of the defendant's brain scan offered by the prosecutor demonstrated that she had "experiential knowledge" available only to the killer. *See* Anand Giridharadas, *India's Use of Brain Scans in Courts Dismays Critics*, THE INT'L HERALD TRIB., Sept. 15, 2008. *See also* Neuroethics and Law Blog: Brain Based Lie Detector Leads to Murder Conviction in India (Lawrence Farwell's Response), http://kolber.typepad.com/ethics_law_blog/2008/09/brain-based-lie.html#comments (providing a brief description of the differences between the Brain Electrical Oscillations Signature test admitted in the Indian court and the EEG-based "brain fingerprinting" technique developed by Lawrence Farwell).

27. *See* Giridharadas, *supra* note 26.

the defendant (who was suspected of poisoning her former fiancé), thirty-two electrodes had been placed on her head while police read her their account of the murder.[28] Despite the fact that the defendant made no verbal responses during the BEOS test, and without reference to any specific evidence of the test's scientific validity, the judge concluded that the BEOS test results proved that she had "experiential knowledge" of the crime.[29]

There are currently two fully operational for-profit fMRI lie detection businesses performing brain scans in Massachusetts[30] and California.[31] Under the circumstances, it is reasonable to assume that U.S. courts will soon confront similar efforts to introduce cognitive neuroscience evidence. In the near future, when cognitive neuroscience evidence is proffered in court, it will be subjected to pre-trial judicial validity screening (like all other expert evidence) under the relevant state or federal evidentiary rules and standards.

1. Threshold Validity Determinations

Ideally, threshold questions of scientific validity are addressed first by the scientists and then by the courts. In the federal courts, and the more than thirty states that have adopted *Daubert*[32] in whole or in part,[33] future admissibility decisions must be based on the scientific validity of proffered cognitive neuroscience evidence.[34] In theory, these judges will operate the tools of science to make these pretrial admissibility determinations. These should include the four flexible factors for assessing scientific validity identified by the *Daubert* Court: (1) testability/falsifiability, (2) peer review and publication, (3) error rate, and (4) general acceptance within the relevant field.[35] However, empirical research and common sense indicate that (in practice) judges generally avoid independent assessments of testability/falsifiability or

28. Anand Giridharadas, *India's Novel Use of Brain Scans in Court is Debated*, N.Y. TIMES, Sept. 15, 2008.

29. *Id.*

30. *See* Cephos Corp: Arranging for fMRI Testing, www.cephoscorp.com/fmri-schedule.htm. During the symposium we learned from Dr. Steven J. Laken (President and CEO of Cephos Corp.) that Cephos currently performs fMRI lie-detection services and charges $4000 per test.

31. *See* No Lie MRI home page, http://www.noliemri.com/centers/Centers.htm (last visited Feb. 23, 2009).

32. *Daubert v. Merrell Dow Pharms.*, 509 U.S. 579, 592-93 (1993).

33. *See* Alice B. Lustre, *Post-*Daubert *Standards for Admissibility of Scientific and Other Expert Evidence in State Courts*, 90 A.L.R. 5th 453 (providing a list of states that have adopted *Daubert*).

34. *Daubert*, 509 U.S. at 592-93.

35. *Daubert*, 509 U.S. at 593-94 (1993).

error rates and rely instead on the validity assessments from within the field often embodied in evidence of general acceptance and peer reviewed publications.[36] Unfortunately, at least for the foreseeable future, judges forced to assess the validity of neuroimages that purport to reveal cognition, deception, or social behavior will find that the *science* of cognitive neuroscience is far from clear.

Courts will soon discover profound disagreement within the relevant cognitive neuroscience community on issues great and small. For example, it was not surprising to learn that symposium participants and fMRI-based lie detection researchers Steven J. Laken (President and CEO of Cephos Corp.) and Dr. Daniel Langleben (Department of Psychiatry, University of Pennsylvania Medical School) dispute the accuracy of particular neuroimaging studies or that they disagree about the specific question of whether valid cognitive neuroscience research requires a 3.0 Telsa MRI machine (an MRI machine of greater magnetic force). However, it was startling (if commendably honest) to hear Dr. Langleben, whom many consider the progenitor of fMRI-based lie-detection, express significant reservations about two foundational cognitive neuroscience assumptions: (1) that truth telling *never* causes more response in the brain than lying, and (2) that neuroscientists can accurately distinguish the brain activity correlates of *salience* from the brain activity correlates of *deception*.

Dr. Langleben's concerns are consistent with questions raised within the field of neuroscience by self-designated "neurorealists."[37] Professor Moriarty gamely attempted to address some of these concerns (from the legal perspective) by providing future courts with practical advice on operating the relevant admissibility standards. However, her work also highlights the fact that judges will soon confront the difficult

36. Sophia I. Gatowski et al., *Asking the Gatekeepers: A National Survey of Judges on Judging Expert Evidence in a Post-*Daubert *World*, 25 LAW & HUM. BEHAV. 433, 445-448 (2001) (noting that a survey of 400 state court judges revealed profound difficulties understanding and applying two of the four flexible *Daubert* factors – falsifiability and error rates – which leads courts to emphasize the remaining two criteria – general acceptance and peer-review/publication).

37. "Neurorealism" is a term frequently credited to bioethicist Éric Racine of the Institut de Recherches Cliniques de Montréal in Canada. According to Racine,

> Our concept of 'neuro-realism' describes how coverage of fMRI investigations can make a phenomenon uncritically real, objective or effective in the eyes of the public. This occurs most notably when qualifications about results are not brought to the reader's attention. For example, commenting on an fMRI study of fear, one article states, 'Now scientists say the feeling is not only real, but they can show what happens in the brain to cause it.'

Racine, *supra* note 10 at 160.

task of assessing scientific validity in this new, complex, and deeply divided scientific field.

2. Anticipating the Impact of Judicial Familiarity with Neuroscience and Neuroimaging Technologies

Judges who will control the admissibility and use of cognitive neuroscience evidence will be hampered by their general lack of scientific training and experience. Recent efforts to train judges in basic science, such as Brooklyn Law School's *Science for Judges*,[38] may eventually improve judicial decision-making by expanding judges' basic scientific knowledge. In the interim, conscientious judges will endeavor to make accurate and consistent decisions based on ambiguous and unsettled scientific information. These decisions should (but probably will not) include some recognition of the possibility that, as Alexander Pope once warned, "a little learning is a dangerous thing."[39]

Many judges will be intimately familiar with MRI scanners and will likely have based significant personal or family medical treatment decisions on neuroimaging test results. This experience will inevitably shape judicial attitudes and preconceptions. The risk is that real judicial decisions (like all other decisions) are based on a variety of powerful but unacknowledged influences. For example, Malcolm Gladwell has postulated that many of our decisions are based on a process of rapid cognition that he describes as "thinking without thinking."[40] Although he does not specifically address legal decision-making, there is common ground between Gladwell's popular work and research efforts by behavioral economists and cognitive psychologists who endeavor to explain how cognitive biases and heuristics influence judicial decision-making.[41]

A comprehensive discussion of the impact of rapid cognition, biases, or heuristics on decision making is far beyond the scope of this Article. However, if we start with Professor Cass Sunstein's definition of heuristics as "the basic claim is that in answering hard factual questions, those who lack accurate information use simple rules of

38. Margaret A. Berger, *Science for Judges*, 12 J. L. & POL'Y 1 (2003).

39. Alexander Pope, AN ESSAY ON CRITICISM (1709).

40. *See* Malcolm Gladwell, BLINK: THE POWER OF THINKING WITHOUT THINKING (Little, Brown and Company 2005). *Blink* is "concerned with . . . the content and origins of those instantaneous impressions and conclusions that spontaneously arise whenever [people] . . . confront a complex situation or have to make a decision under conditions of stress." *Id.* at 16.

41. *See generally* Jeffrey J. Rachlinski, *Heuristics and Biases in the Courts: Ignorance or Adaptation?*, 70 OR. L. REV. 61 (2000) (describing the impact of cognitive biases and heuristics on decisions by judges and juries).

thumb,"[42] it is easy to envision judges relying on such rules of thumb as the "availability heuristic" (which explains our tendency to replace more difficult and more accurate probability assessments with examples that more readily spring to mind) or the "representativeness heuristic" (which explains why we tend to make both warranted and unwarranted assumptions of commonality). In this context, judges who unconsciously rely on mental shortcuts (as we all do) are likely to overestimate the validity of neuroimages that purport to reveal cognition. This is because judges will mistakenly equate proffered brain scans with more familiar radiographic images or mistakenly assume that technologies that are demonstrably valid medical diagnostic tools yield equally valid conclusions when they are used to map the neural correlates of cognition..

Cognitive neuroscience evidence will create especially complicated problems for future courts, because this research involves new applications of well-established technologies. These specific problems have been described by bioethicist Eric Racine, who frequently expresses his concern about the "uncritical way in which an fMRI investigation can be taken as validation or invalidation of our ordinary view of the world . . . [and] the belief that fMRI enables us to capture a 'visual proof' of brain activity, despite the enormous complexities of data acquisition and image processing."[43] Similar validity concerns have been raised by other neurorealists, like Dr. Russell Poldrack of U.C.L.A., who warns that

> [a]s cognitive neuroscientists who use the same brain imaging technology, we know that it is not possible to definitively determine whether a person is anxious or feeling connected simply by looking at activity in a particular brain region. This is so because brain regions are typically engaged by many mental states . . . .[44]

In addition to raising general questions about the validity of many cognitive neuroscience-based conclusions, Dr. Poldrack also addresses the more specific problem of reversed causal inferences, which occurs

> where people see some activity in a brain area and then conclude that this part of the brain is where X happens. We can show that if I put you into a state of fear, your amygdala lights up, but that doesn't mean

42. Cass R. Sunstein, *Moral Heuristics and Moral Framing*, 88 MINN. L. REV. 1556, 1560 (2004).

43. *See* Racine, *supra* note 10.

44. Michael Shermer, *The Brain is Not Modular: What fMRI Really Tells Us: Metaphors, Modules and Brain Scan Pseudoscience*, SCI. AM., May 13, 2008, http://www.sciam.com/article.cfm?id=a-new-phrenology.

> that every time your amygdala lights up you are experiencing fear. Every brain area lights up under lots of different states. We just don't have the data to tell us how selectively active an area is.[45]

Another specific problem may be the quality of cognitive neuroscience data analysis. A very recent article entitled *Puzzlingly High Correlations in fMRI Studies of Emotion, Personality, and Social Cognition* involved a meta-analysis of the empirical findings reported in fifty-two social neuroscience articles that relied upon fMRI studies.[46] Social neuroscience is a sub-field of cognitive neuroscience that seeks to correlate brain activity and social behavior. Dr. Vul and his research team explored the analytic methods described in the fifty-two published studies and found that *more than half* suffered from significant problems of distorted data and biased correlation analysis.[47] This led Dr. Vul to "conclude that a disturbingly large, and quite prominent, segment of social neuroscience research is using seriously defective research methods and producing a profusion of numbers that should not be believed."[48] As these few examples reveal, cognitive neuroscience is an unsettled and controversial new field marked by significant concerns about the validity of even peer-reviewed and published research. Judges will need to understand the nature and extent of these debates to ensure that they do not oversimplify and overvalue conclusions that appear to be supported by brain imaging studies.

3. The Valid and Reasonable Application Requirement

To be admitted in court, scientific evidence must not only rest on generally valid principles and methods, but these principles and methods must have been validly and reasonably applied to the specific facts at issue. This requirement was added to Federal Rule of Evidence 702 in December 2000[49] after Justice Breyer emphasized its importance in *Kumho Tire Co. v. Carmichael*.[50] Writing for the *Kumho* majority, Justice Breyer noted that, based on the relevant facts in that case,

45. *Id.*

46. *See* Vul et al., *supra* note 12, at 13 ("Thus, in half of the studies we surveyed, the reported correlation coefficients mean almost nothing, because they are systematically inflated by the biased analysis.")

47. *Id.*

48. *Id.*

49. Fed. R. Evid. 702 (permitting expert testimony when "(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").

50. *Kumho Tire Co. v. Carmichael*, 526 U.S. 137, 137 (1999).

> [t]he specific issue before the [district] court was not the reasonableness in general of a tire expert's use of a visual and tactile inspection, [but was instead] the reasonableness of using such an approach . . . to draw a conclusion regarding the particular matter to which the expert testimony was directly relevant.[51]

A more colorful and equally persuasive example is Justice Blackmun's *Daubert* werewolf.[52] Writing for the *Daubert* majority, Justice Blackmun explained that valid moon phase studies should be admitted to reveal lighting conditions; but that these same studies should be excluded if they have been proffered to explain the criminal defendant's bizarre behavior.[53] Thus, in the cognitive neuroscience context, research designed to reveal deception that is based on the brain activity of subjects who have been instructed to lie about insignificant events under highly artificial conditions should be excluded unless and until there is adequate empirical evidence demonstrating that this research can reasonably and reliably be applied to the case.

Cognitive neuroscience, like all nascent scientific fields will raise new and interesting science and law questions. Judges who overestimate the validity of this evidence because they equate it with diagnostic medical imaging or mistakenly assume valid application to the facts at issue invite jurors to rely on cognitive neuroscience evidence that is, as Don Pardo might say, "not ready for prime time."[54] At the individual case level, jury reliance on evidence of dubious validity will lead to inconsistent and illegitimate verdicts. The systemic concerns raised by legal reliance on this type of evidence are more profound. If cognitive neuroscience enters our civil and criminal courts prematurely, a legal imprimatur of validity will inevitably spill over to other cases and to the world outside the courthouse.

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51. *Id.* at 153-54.

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

53. *Id.* ("The study of the phases of the moon, for example, may provide valid scientific 'knowledge' about whether a certain night was dark, and if darkness is a fact in issue, the knowledge will assist the trier of fact. However (absent creditable grounds supporting such a link), evidence that the moon was full on a certain night will not assist the trier of fact in determining whether an individual was unusually likely to have behaved irrationally on that night."). In earlier work, I have posited that *Kumho Tire Co.,* 526 U.S. 137, was designed to encourage future courts to focus more careful attention on the relevance/application question rather than to simply assume that the general validity of an expert's field or opinion necessarily implies that the evidence fits the case at hand. *See* Joëlle Anne Moreno, *Beyond the Polemic Against Junk Science: Navigating the Oceans that Divide Science and Law With Justice Breyer at the Helm*, 81 B.U. L. REV. 1033, 1049-1055 (2001).

54. Don Pardo is the long time announcer for *Saturday Night Live*.

4. The Potential Effects of Legal Reliance on Cognitive Neuroscience Evidence

Law does not occur in a vacuum. Legal decisions involving science implicate the legitimacy of both law and science. In fact, as Justice Breyer has observed, "[t]he importance of scientific accuracy in the decision of [science-based] cases reaches well beyond the case itself"[55] because

> [a] decision wrongly denying compensation in a toxic substance case . . . can deprive not only the plaintiff of warranted compensation but can discourage other similarly situated individuals from even trying to obtain compensation and can encourage the continued use of a dangerous substance. On the other hand, a decision wrongly granting compensation, although of immediate benefit to the plaintiff, through the strong financial disincentives that accompany a finding of tort liability, can improperly force abandonment of the substance. Thus if the decision is wrong, it will improperly deprive the public of what can be far more important benefits -- those surrounding a drug that cures many while subjecting a few to less serious risk, for example.[56]

Because, according to Justice Breyer, individual science-based legal decisions redound to law, science, and society, "[t]he upshot is that we must search for law that reflects an understanding of the relevant underlying science."[57] Justice Breyer's fear that bad legal thinking about science can yield not only bad law, but bad *science* has been realized in controversies that range from the silicone breast implant litigation of the early 1990s[58] to some very recent decisions authorizing damages for autism-related injuries following plaintiffs' MMR vaccines.[59] When judges legitimize pseudoscientific ideas by accepting them into their courtrooms, the repercussions of these decisions transcend the individual cases. As we know from our experience with

55. Associate Justice Stephen J. Breyer, *The Interdependence of Science and Law*, 280 SCIENCE 537, 537 (Apr. 24, 1998).

56. *Id.*

57. *Id.*

58. For a detailed analysis of the impact of judicial pseudoscience on legitimate science, regulatory actions, and social expectations in the breast implant context see Marcia Angell, SCIENCE ON TRIAL: THE CLASH OF MEDICAL EVIDENCE AND THE LAW IN THE BREAST IMPLANT CASE (W.W. Norton & Co. 1996).

59. *See* Arthur Allen, Treating Autism as if Vaccines Caused it, Slate 4/1/09 (describing how parents who mistakenly believe that autism is caused by thimerisol (a now-discontinued MMR vaccine preservative) subject their children to dangerous and ineffective chelation therapy). *See generally* Joëlle Anne Moreno, *Toxic Torts, Autism, and Bad Science: Why the Courts May Be Our Best Defense Against Scientific Relativism*, 40 NEW ENGL. L. REV. 409 (2006).

the forensic sciences, misunderstandings about scientific validity are compounded when judges mistake repeated admission at trial (general acceptance in the courts) for general acceptance within the relevant scientific community.

Within the field, profound validity concerns currently divide cognitive neuroscientists. Outside the field, premature social and legal legitimatization of this type of evidence increase the risk that our borders will be patrolled by MALINTENT–style mind-reading machines and our courtrooms equipped with light boxes so that jurors can consider radiologic images when assessing credibility or behavior. Under the circumstances, it was surprising that so many symposium participants merely mentioned and then breezed past these concerns. Their goal was apparent. Most of the commentators were so anxious to explore the uncharted philosophical, bioethical, jury nullification, substantive criminal law, and constitutional implications of future mind-reading technologies that they simply assumed away threshold accuracy concerns.[60]

One notable exception was Professor Michael Perlin, who clearly prefers the "Slow Train"[61] to cognitive neuroscience evidence. Professor Perlin focused his analysis on the potential in-court use of brain images to support insanity defense arguments. He expressed significant skepticism about the potential validity of new mind-reading technologies especially when balanced against the powerful visceral jury appeal of colorful pictures that appear to reduce the complexity of psychological phenomena. Given the fact that American juries are increasingly exposed to physiological explanations for aberrant behavior, radiologic images (as a component of even routine healthcare), and cognitive neuroscience information in the mainstream media, Professor Perlin's concerns are prescient. Although there is no easy fix, Professor Perlin suggested that courts should endeavor to resolve important threshold validity problems (*e.g.*, the effect of various anti-psychotic medications routinely given to criminal defendants on brain

60. In addition to the symposium presenters, this list should include scholars like Professor Michael Pardo, who (in other fora) has addressed the question of whether accurate neuroscience-enhanced interrogation and lie detection will force a reconceptualization of various fundamental constitutional rights and privileges. *See*, *e.g.*, Michael S. Pardo, *Evidence, Legal Culture, and Criminal Procedure*, 33 AM. J. CRIM. L. 301 (2006) (exploring the possible impact of neuroscientific evidence on the Fourth Amendment, the Self Incrimination Clause, and Due Process rights).

61. This is a friendly reference to Professor Perlin's well-known abiding interest in the words and music of Bob Dylan. *See* Nick Paumgarten, *Another Side of Bob Dylan*, THE NEW YORKER, Nov. 18, 2002, *available at* http://www.newyorker.com/archive/2002/11/18/021118ta_talk_paumgarten.

functioning) and threshold legal problems (*e.g.*, defendant consent and access to public funds for the neuroimaging of indigent defendants) *before* they begin to allow cognitive neuroscience evidence to alter the insanity playing field.

C. Extra-Legal Uses of Cognitive Neuroscience

The symposium also presented a balance of perspectives on a variety of extra-legal uses of future cognitive neuroscience evidence. These included two different discussions of the investigatory implications of neuroimaged deception detection from Professor Christian Halliburton and Dr. Dov Fox and Professor Stacey Tovino's exploration of the impact of new neuroscience evidence on health insurance coverage for a variety of gender-specific health conditions.

Professor Jonathan Marks focused our attention on the counterterrorism applications of cognitive neuroscience. According to Professor Marks, who has obtained extensive discovery from the Department of Defense, the Department recently renewed its commitment to developing new deception detection technology when it renamed its "Polygraph Institute" the "Defense Academy for Credibility Assessment."[62] Professor Marks did not discuss MALINTENT, but presumably he is anticipating that the Defense Department will develop and promote a variety of new, sophisticated, well-funded deception detection technologies. Professor Marks' specific concerns about the extralegal implications of new "mind reading" technologies include: (1) the small number of test subjects that form the basis of existing studies, (2) the artificiality of cognitive neuroscience testing environments, (3) the temporal limits of fMRI neuroimaging technology (which may fail to capture constant changes in brain activity), (4) variations in neuroanatomy, (5) the fact that deception is a complex situation-dependant thought process, and (6) variations in response to test questions based on cultural expectations and subjective perceptions. Many of these same concerns should be shared by those who anticipate the potential in-court applications of cognitive neuroscience evidence.

62. *See* Department of Defense Directive Number 5210.48 (Jan. 25, 2007) at §1.5 (renaming the Department of Defense's Polygraph Institute the Defense Academy for Credibility Assessment), http://www.dtic.mil/whs/directives/corres/pdf/521048p.pdf.

II. HOW SHOULD LAW (AND LAW PROFESSORS) RESPOND TO COGNITIVE NEUROSCIENCE?

In the airport on the way home from Akron, I commented to a fellow symposium participant that our discussions, which were streamed live on the internet and would soon be embodied in a series of articles, could alter the perceived validity of cognitive neuroscience evidence within the practicing legal community. My specific concern is that intellectually stimulating explorations of the potential legal value and future impact of neuroimages that appear to correlate brain activity with cognition, deception, or social behavior might themselves alter the playing field by conferring a premature aura of legitimacy to this type of evidence. This risk is enhanced by the fact that judges and lawyers who learn about this conference (and other cognitive neuroscience and law discussions) start with a common belief that the field relies demonstrably valid imaging technologies. Finally, these concerns are also heightened by the fact that during this symposium (and the AALS Mid-Year Conference on Evidence in June 2008) cognitive neuroscience researchers spoke optimistically about the validity of their work; although this may be partially attributable to their vested financial interest in the future profitability of businesses that engage in fMRI-enhanced lie detection.[63]

In other words, when law professors play in the field of science, should we be bound by the home team rules? It is certainly interesting and fun to imagine how accurate brain scans revealing deception might change police interrogations, but if we ignore or underemphasize genuine validity problems or marginalize neurorealists and other critics from within the field, are we inadvertently encouraging courts and practitioners to follow our example? This law professor's answer was simple – academics have no responsibility and should have limited interest in what judges and lawyers do. I appreciated his candor, but my plane was about to depart so I had little time to consider his position or respond. With the benefit of time to reflect and a growing sense that his view is not unique, I have saved the final section of this Article for a brief response.

63. During three months in mid-2008, I attended two different legal academic conferences that included presentations on the validity of fMRI-enhanced lie detection from Steven J. Laken, President and CEO of Cephos Corp., which offers a for-profit lie detection service. *See supra* note 30 and accompanying text.

A. Understanding the Value and Limits of Cognitive Neuroscience

It is easy for law professors to recognize that science shapes law, but harder sometimes to see how law shapes science (or at least shapes our understanding of scientific developments and controversies). So, at the risk of apostasy, I will suggest that academic prognosticators should bear some responsibility for weighing the obvious (and perhaps the less obvious) social costs of assuming, even for the sake of argument, the existence of accurate neuroimages of cognition, deception, or social behavior. This should not be misunderstood as a preference for silence or a desire to chill interdisciplinary debate. Instead, I offer two modest guiding principles for future conversations.

First, as we wade into this new field we should be careful not to omit or obscure the fact that our theoretically interesting explorations of the philosophical, bioethical, or constitutional ramifications of cognitive neuroscience evidence are misleading in the short term and useless in the long term if the field fails to establish through unbiased, independent, and reliable research that neuroimaging accurately reveals not just the blood flow in a subject's brain, but the content of her mind.[64] Second, we should more thoroughly address the potentially problematic consequences of imminent legal and extralegal reliance on cognitive neuroscience evidence that is prematurely or inaccurately presumed by courts (or perhaps the Department of Defense) to be valid, but actually falls short of any reasonable threshold validity standards.

Academics who acknowledge these risks and shortcomings can find good company among the neurorealists. But the greatest obstacle to circumspection is not my ivory-tower ensconced colleague. Instead, it is our shared human curiosity about the inner workings of the mind combined with our apparently insatiable desire to distill complex psychological phenomena into simple explanations that can be easily illustrated with brightly colored pictures.

B. Brain Research is Sexy

Cognitive neuroscience research (even research of dubious validity) has the potential to shape legal and extralegal decisions because it is profoundly interesting and appealing. For example, the "liar, liar, brain

64. I do not mean to suggest that these concerns are entirely ignored. For example, Professor Greely's keynote address (and his post-symposium blog report) included a discussion of "the need to balance talking about the possible implications of speculative technologies with asking always whether these technologies work or are likely to work." Hank Greely, University of Akron Law and Neuroscience Conference, (Oct. 20, 2008) http://lawandbiosciences.wordpress.com/2008/10/20/university-of-akron-law-and-neuroscience-conference/.

on fire" possibility was first explored by symposium panelist and Professor of Psychiatry Daniel Langleben of the University of Pennsylvania Medical School. Starting in the late 1990s, Professor Langleben began to use fMRI technology to explore the neural correlates of deception. Over the past two decades, neuroresearchers around the world have embarked on similar deception detection studies.[65]

Other cognitive neuroscience research projects with obvious legal and social implications (not discussed at the symposium) should include the recent work of Professor Elizabeth Phelps of New York University. Professor Phelps has used fMRI scans to assess unconscious racism by measuring how long it takes test subjects to associate positive adjectives with black and white faces and comparing this to measurements of subjects' amygdala blood flow activity.[66] A third example (also not discussed at the symposium), is new research from Columbia University Medical Center on the potential impact of repeated exposure to violent images. These researchers found that fMRI scans of subjects repeatedly exposed to images of violence revealed diminished activity in the right lateral orbitofrontal cortex (the brain area purportedly associated with control over reactive aggressive behavior).[67] As you can imagine, these studies are just the tip of the cognitive neuroscience iceberg.

C. Brain Research is Persuasive

The risk of premature reliance on cognitive neuroscience research is also enhanced by recent studies demonstrating that research conclusions that appear to be supported by neuroscience data and/or brain scans are far more likely to be accepted and believed even when they are otherwise illogical.

1. Brain Scan Images Enhance Perceived Validity

Neuropsychologists from the University of Colorado recently studied the impact of brain images on judgments of scientific reasoning. This study exposed 156 undergraduate participants to fictional news

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65. A Medline search run on October 1, 2008 revealed twenty-two research papers describing studies of neuroimaged lie detection. The first two studies were published by Dr. Langleben (Department of Psychiatry, University of Pennsylvania Medical School) and Dr. Lee (Department of Psychology, University of Hong Kong) in March 2002.

66. Jeffrey Rosen, *The Brain on the Stand*, N.Y. TIMES, Mar. 11, 2007.

67. Christopher R. Kelly, et al., *Repeated Exposure to Media Violence is Associated with Diminished Response in an Inhibitory Frontolimbic Network*, PLOS ONE, (Dec. 2007), *available at* http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0001268.

articles summarizing cognitive neuroscience research.[68] Each article was presented either without images, with an accompanying bar graph, or with accompanying brain scan images.[69] The objective was to determine whether the bar graph and/or brain scan images enhanced the persuasive appeal of the research conclusions.

Researchers discovered that whenever neuroscience articles were accompanied by brain scan images (but not when they were accompanied by bar graphs), the perceived scientific merit of the article was significantly increased.[70] This change occurred even when the text of the article was riddled with scientific reasoning errors.[71] These findings led the researchers to conclude that "[b]rain images may be more persuasive than other representations of brain activity because they provide a tangible physical explanation for cognitive processes that is easily interpreted as such."[72]

2. Cognitive Neuroscience Explanations (Even Without Brain Scan Images) Enhance Perceived Validity

A 2008 study published in the *Journal of Cognitive Neuroscience* explored the recent and intense public interest in neuroscience explanations of human behavior.[73] To better understand why neuroscience is so intriguing to the general public, Yale University neuropsychologists hypothesized that people might "uncritically accept any explanation containing neuroscience information, even in cases when the neuroscience information is irrelevant to the logic of the explanation."[74] In this study, participants were asked to rate the quality of good and bad explanations of scientific phenomena. Neuroscience information such as "brain scans indicate" and descriptions of "frontal lobe brain circuitry" were inserted into both good and bad explanations.[75]

Researchers found that when the neuroscience references were omitted, subjects who ranged from novices, to students (members of an introduction to cognitive neuroscience class), to experts (individuals who were pursuing or had completed advanced cognitive neuroscience degrees) could readily distinguish between the good and bad scientific

68. McCabe & Castel, *supra* note 20, at 345.
69. *Id*.
70. *Id*. at 346.
71. *Id*. at 345-46.
72. *Id*. at 349.
73. *See* Weisberg, *supra* note 20.
74. Weisberg, *supra* note 20, at 470.
75. *Id.* at 471.

explanations.[76] However, for novices and students, the introduction of (even irrelevant) references to brain scans and frontal lobe brain circuitry caused participants to overestimate the quality of the bad explanations.[77] Based on this data, the researchers concluded that "the neuroscience information provided them with a physical explanation for a behavioral phenomenon . . . [which] made the bad behavioral explanations seem connected to a larger explanatory system, and hence more insightful."[78]

These recent University of Colorado and Yale University studies suggest that cognitive neuroscience evidence and brain scan images are incredibly appealing, even to sophisticated audiences. These findings have significant implications for our anticipated reliance on cognitive science research in legal and extralegal contexts. In fact, the Yale study contains a very explicit warning – cognitive neuroscience evidence "presented in a courtroom, a classroom, or a political debate, regardless of the scientific status or relevance of the evidence, could strongly sway opinion, beyond what the evidence can support."[79]

III. CONCLUSION

The question is not whether cognitive neuroscience will change law, but whether cognitive neuroscience *should* change law now (or in the reasonably foreseeable future). More knowledge about how the brain works and better images of brain activity have obvious social value. However, as the debates within the field reveal, deciding when law can derive genuinely valid and useful information from neuroscience research on cognition/deception will be neither easy nor obvious. Perhaps Arthur Clarke was right that ultimately "any sufficiently advanced technology is indistinguishable from magic."[80] One day cognitive neuroscientists might perform the magic of accurate mind reading. In the interim, law professors, judges, and lawyers should continue to work with neuroscientists (including neurorealists) to understand the value and the limits of their research.

76. *Id.* at 475.
77. *Id.* at 472-73, 475.
78. *Id.* at 476.
79. *Id.* at 477.
80. Arthur C. Clarke, PROFILES OF THE FUTURE 36 (Holt, Rinehart, and Winston 1962).