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LIE-DETECTION, NEUROSCIENCE, AND THE LAW OF EVIDENCE

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Abstract

This paper, prepared for the "State of the Art" Law and Neuroscience Conference at the Rutgers (Camden) University School of Law, has two goals. One is to describe comprehensively the current court cases, scientific research, academic literature, and controversies about the potential use of Functional Magnetic Resonance Imaging (fMRI) for detecting deception in court and other forensic contexts. The other is to suggest that the question of the admissibility of fMRI deception evidence in court cannot be thought of as being an exclusively scientific question. The appropriate use or non-use of science in the legal system involves inevitably normative questions about the appropriate levels of accuracy, reliability and validity, questions that must be answered in light of the goals of the legal system and the particular purposes to which the science would be put. The answers require getting the science right, and thus require the involvement of science and scientists, but the ultimate question of when and how the scientific conclusions so produced will be used is a question of legal policy as to which neither scientists nor lawyers should be given exclusive authority.

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Frederick Schauer[1]

A prominent characteristic of the Anglo-American trial is its substantial reliance on second-hand knowledge. Barred almost completely from engaging in direct factual investigation, judges and jurors overwhelmingly rely instead on the accounts of others. Of course trials are not unique in depending on the representations of intermediaries in reaching factual conclusions. Testimony is, after all, a significant part of our everyday epistemic life.[2] But in law, more than in life in general, the testimony of witnesses regarding *their* observations comes close to displacing direct observation by the decision makers, for law is especially vigilant

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[2] Testimony has of late become a topic of active philosophical interest. See, for example, C.A.J. Coady, *Testimony: A Philosophical Study* (Oxford: Clarendon Press, 1995); Elizabeth Fricker, "The Epistemology of Testimony," *Proceedings of the Aristotelian Society* (Supp.), vol. 61 (1987), pp. 57-83; Peter Lipton, "The Epistemology of Testimony," *Studies in the History and Philosophy of Science*, vol. 29 (1998), pp. 1-31.

not only in failing to employ direct investigation by judges and jurors , but also in generally prohibiting it.

The American legal system combines its reliance on the testimony of others with another important characteristic of the common law trial – the adversary system. Unlike the process in some civil law jurisdictions, Anglo-American judges are extremely limited in their power to call witnesses, manage the factual investigation, or structure the presentations at trial. Rather, witness testimony and other evidence are offered by opposing parties whose goal is victory rather than truth. As a result, the oral testimony that constitutes the bulk of the evidence in almost all trials is put forth and structured by one or another of two (or more) decidedly self-interested parties.

When the reliance on testimony is combined with the self-interested adversarial nature of testimonial presentation, what emerges is an obvious concern with determining whether witnesses are telling the truth. Indeed, efforts to guarantee or assess the veracity of witnesses are a major component of the trial process. Historically, the oath was the device designed to assure witness truthfulness,[3] but even if the oath ever effectively served such a function, which may itself be doubtful, it serves it much less now. People are less likely than in the past to believe that telling a lie under oath will incur the wrath of God or the perpetual fires of Hell,[4]

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[3] See Note, "A Reconsideration of the Sworn Testimony Requirement: Securing Truth in the Twentieth Century," *Michigan Law Review*, vol. 75 (1977), pp. 1681-1707.

[4] This is an empirical and not a theological claim. I have no idea whether people who tell lies under oath are punished for it in an afterlife, but the extent to which people *believe* that people who tell lies are punished by God for it is an empirical question that could much more easily be investigated.

and successful prosecutions for perjury are difficult and consequently rare.[5] Moreover, the ability of a skillful cross-examiner to expose a liar, while long a staple of motion pictures and television, is substantially less effective in real life than it is on the screen.[6] And thus the task of determining whether a witness is telling the truth falls largely on the trier of fact, sometimes a jury and sometimes a judge.[7] In carrying out this task, jurors and judges are expected to rely on their own perceptions, experiences, and abilities, but it is now well-known that the ability of most ordinary and even some well-trained people to distinguish the liar from the truth-teller is quite limited.[8] This is not surprising, because most jurors and many judges use an array of

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[5] See Ted Sampsell-Jones, "Making Defendants Speak," *Minnesota Law Review*, vol. 93 (2009), pp. 1327-1376, at p. 1370.

[6] See Jules Epstein, "The Great Engine That Couldn't: Science, Mistaken Identifications, and the Limits of Cross-Examination," *Stetson Law Review*, vol. 36 (2007), pp. 727-787, at pp. 774-782; Marvin E. Frankel, "The Search for Truth: An Umpireal View," *University of Pennsylvania Law Review*, vol. 123 (1975), pp. 1031-1059; John L. Watts, "To Tell the Truth: A Qui Tam Action for Perjury in a Civil Proceeding is Necessary to Protect the Integrity of a Civil Judicial System," *Temple Law Review*, vol. 79 (2006), pp. 773-819, at p. 775.

[7] See George Fisher, "The Jury's Rise as a Lie Detector," *Yale Law Journal*, vol. 107 (1997), pp. 575-708; *United States v. Barnard*, 490 F.2d 907, 912 (9th Cir. 1973); *United States v. Thompson*, 615 F.2d 329, 332 (5th Cir. 1980); *State v. Myers*, 382 N.W.2d 91, 95 (Iowa 1986).

[8] See Charles F. Bond, Jr. & Bella M. DePaulo, "Individual Differences in Detecting Deception," *Psychological Bulletin*, vol. 134 (2008), pp. 477-492; Charles F. Bond, Jr. & Bella M. DePaulo, "Accuracy of Deception Judgments," *Personality and Social Psychology Review*, vol. 10 (2006), pp. 214-234; Gary D. Bond, "Deception Detection Expertise," *Law & Human Behavior*, vol. 32 (2008), pp. 339-351; Bella M. DePaulo, *et al.*, "Cues to Deception," *Psychological Bulletin*, vol. 129 (2003), pp. 74-118; Bella M. DePaulo, *et al.*, "The Accuracy-Confidence Correlation in the Detection of Deception," *Personality & Social Psychology Review*, vol. 1 (1997), pp. 346-357; Amy-May Leach et al., "The Reliability of Lie-Detection Performance," *Law & Human Behavior*, vol. 33 (2009), pp. 96-109; Christian A. Meissner & Saul M. Kassin, "'He's Guilty!': Investigator Bias in Judgments of Truth and Deception," *Law & Human Behavior*, vol. 26 (2002), pp. 469-480. On the highly contested possibility that some people – the so-called truth wizards – are substantially better than most people at detecting deception, see Maureen O'Sullivan, "Home

primarily non-verbal indicators of veracity – looking directly at the jury and speaking with confidence, for example – whose alleged reliability stems far more from folk psychology and urban legend than it does from serious scientific research.[9]

In the face of these multiple obstacles to the determination of witness veracity, it should come as little surprise that the legal system has long searched for better and often technological methods of determining who is telling the truth and who is not. The first lie-detecting machines were created in the early twentieth century, and efforts to employ them in criminal and civil litigation followed not long thereafter.[10] In 1923, however, in the case that was also to establish the standard for the use of scientific evidence generally for more than half a century, the United States Court of Appeals for the District of Columbia rejected the use of a lie-detector at trial, the court relying for its conclusions on the fact that the methodology

Runs and Humbugs: Comment on Bond & DePaulo," *Psychological Bulletin*, vol. 134 (2008), pp. 493-497; Maureen O'Sullivan, "Why Most People Parse Palters, Fibs, Lies, Whoppers, and Other Deceptions Poorly," in Brooke Harrington ed., *Deception: From Ancient Empires to Internet Dating* (Stanford, CA: Stanford University Press, 2009), pp. 74-94.

[9] Aldert Vrij, "Nonverbal Dominance Versus Verbal Accuracy in Lie Detection: A Plea to Change Police Practice," *Criminal Justice & Behavior*, vol. 35 (2008), pp. 1323-1336; Richard Wiseman, et al., "The Eyes Don't Have It: Lie Detection and Neuro-Linguistic Programming," *PLoS ONE*, vol. 7 (2012): e40259. Doi:10.1371/journal.pone.0040259. Legal analyses of the psychological literature include Jeremy Blumenthal, "A Wipe of the Hands, A Lick of the Lips: The Validity of Demeanor Evidence in Assessing Witness Credibility," *Nebraska Law Review*, vol. 72 (1993), pp. 1157-1203; Max Minzner, "Detecting Lies Using Demeanor, Bias, and Context," *Cardozo Law Review*, vol. 29 (2008), pp. 2557-2579; Olin Guy Wellborn III, "Demeanor," *Cornell Law Review*, vol. 76 (1991), pp. 1075-1105.

[10] See Elizabeth B. Ford, "Lie Detection: Historical, Neuropsychiatric and Legal Dimensions," *International Journal of Law & Psychiatry*, vol. 29 (2006), pp. 159-177.

employed was not yet sufficiently "generally accepted" within the relevant scientific community.[11]

The crude polygraphs of 1923 have been successively replaced by continuously more sophisticated and more accurate ones. Moreover, the underlying methods of the traditional polygraph – the measurement of heart rate, respiration (breathing) rate, systolic blood pressure, perspiration, and occasionally bodily movements – have been joined by quite different technologies and techniques, including the analysis of facial micro-expressions, the measurement of blood flow and body temperature around the eyes, and the analysis of brain-generated electric current. But none of these methods have fared much better than the basic polygraph in their quest to be accepted for courtroom use. All remain techniques commonly used in employment and other non-forensic contexts, but they are still generally excluded from use in court. This continuing exclusion is based partly on the grounds that all of the existing methods of technological lie-detection are not sufficiently accurate or reliable, and partly on the basis of the belief that, even to the extent that these methods have some degree of reliable accuracy, judges and, especially, jurors are likely to believe them far more accurate and reliable than they actually are.

Within the last decade, however, the nature of the issue has changed, largely because of claims that the methods of modern neuroscience can, in essence, produce a better lie-detector. The use of fMRI (functional magnetic resonance imaging) examination, it is said, is or will soon become substantially more reliable as an accurate detector of deception than any of its

[11] *Frye v. United States*, 293 F. 1013 (D.C. Cir. 1923).

predecessors. As a consequence of these advances, some proponents of the new methods have urged that it should, now or in the near future, be accepted for a wide range of forensic uses, including but not limited to use in court as a measure of the veracity of those whose in-court or out-of-court statements constitute admissible evidence.

There is little doubt that the techniques of modern neuroscience are advancing at an impressive pace, but whether the reliability of those techniques in the context of detecting deception has reached a point where their use should be permitted in trials has become a subject of heated and active debate. Many prominent neuroscientists and others have been insisting that the current level of reliability and validity of the research allegedly supporting it are not nearly sufficient to justify actual courtroom use,[12] while the commercial proponents of the technology,[13] some lawyers,[14] and some scientists[15] are more sympathetic, urging with

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[12] See Michael S. Gazzaniga, "The Law and Neuroscience," *Neuron*, vol. 60 (2008), pp. 412-413; Henry T. Greely & Judy Illes, "Neuroscience-Based Lie Detection: The Urgent Need for Regulation," *American Journal of Law & Medicine*, vol. 33 (2007), pp. 377-431; Nancy Kanwisher, "The Use of fMRI in Lie Detection: What Has Been Shown and What Has Not," in Emilio Bizzi & Steven E. Hyman, *Using Imaging to Identify Deceit: Scientific and Ethical Questions* (Cambridge, MA: American Academy of Arts and Sciences, 2009), pp. 7-13; Elizabeth A. Phelps, "Lying Outside the Laboratory: The Impact of Imagery and Emotion on the Neural Circuitry of Lie Detection," in Bizzi & Hyman, *ibid.*, pp. 14-22. See also The Royal Society, *Brain Waves Module 4: Neuroscience and the Law* (London: The Rotal Society, 2011), pp. 25-26.

[13] See Cephos Corp., http://www.cephoscorp.com; NoLie MRI, http://www.noliemri.com.

[14] See Neal Feigenson, "Brain Imaging and Courtroom Evidence: On the Admissibility and Persuasiveness of fMRI," *International Journal of Law in Context*, vol. 2 (2006), pp, 233-255. Leo Kittay, Note, "Admissibility of fMRI Lie Detection: The Cultural Bias Against 'Mind Reading' Devices," *Brooklyn Law Review*, vol. 72 (2007), pp. 1351-1399. And see also the proceedings in *United States v. Semrau*, No. 07-10074 M1/P (United States District Court for the Western District of Tennessee, May 31, 2010), which rejected the defense's attempt to offer fMRI evidence supporting the defendant's claim of lack of fraudulent intent. The result was similar in *Wilson v. Corestaff Services, LLP*, 900 N.Y.S.2d 639 (Sup. Ct. 2010).

increasing frequency the use now of the methods that have been developing over the last decade or more. The principal goal of this chapter is to review the state of that debate in light of the state of the science and the state of the law, with a secondary goal being to suggest that the question is not one that can be answered by science or scientists alone. The questions of whether a given methodology is sufficiently accurate or reliable for courtroom use, and whether that accuracy and reliability has been established by sufficiently valid methods, are questions demanding not only good scientific analysis, but also irreducibly evaluative and normative answers. Providing those answers accordingly requires going beyond the science into the law, the ethics, and the psychology of legal decision making. These are realms in which scientists have an essential role to play, but the ultimately normative and non-scientific nature of the questions means that neither science nor scientists can provide conclusive answers or be justifiably treated as society's or the law's final or exclusive decision-makers.

I. Lie Detection and the Law – A Brief History

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[15] See Mart Bles & John-Dylan Haynes, "Detecting Concealed Information Using Brain-Imaging Technology," *Neurocase*, vol. 14 (2008), pp. 82-92; Rachel S. Fullam, *et al.*, "Psychopathic Traits and Deception: Functional Magnetic Resonance Imaging Study," *British Journal of Psychiatry*, vol. 194 (2009), pp. 229-235; F. Andrew Kozel, *et al.*, "Detecting Deception Using Functional Magnetic Imaging," *Biological Psychiatry*, vol. 58 (2005), pp. 605-13; F. Andrew Kozel *et al*., "Functional MRI Detection of Deception after Committing a Mock Sabotage Crime," *Journal of Forensic Sciences*, vol. 54 (2009), pp. 220-231; Daniel D. Langleben, "Telling Truth from Lie in Individual Subjects with Fast Event-Related fMRI," *Human Brain Mapping*, vol. 26 (2005), pp. 262-272; Sean A. Spence *et al*., "A Cognitive Neurobiological Account of Deception: Evidence from Functional Neuroimaging," *Philosophical Transactions of the Royal Society of London*, vol. 359 (2004), pp. 1755-1762.

Modern lie-detection is often understood to have begun with John A. Larson's invention of a lie-detection machine in 1921.[16] Although earlier devices created by James Mackenzie, Cesare Lombroso, and William Moulton Marston (also the creator of the Wonder Woman comic book character) had measured blood pressure as a way of identifying deceptive behavior, Larson's device was the first to combine measurements of blood pressure with those of respiration rate. Larson's multiple-measurement technology was made even more sophisticated by Leonarde Keeler in the 1930s, and the Keeler machine – measuring systolic blood pressure, heart rate, respiration rate, and perspiration – became the precursor of the multi-measurement machines still in common use today.

Lie-detection technology need not have been initially developed principally for forensic purposes. In non-forensic contexts, after all, people have an interest in knowing whether their lovers, children, plumbers, and stockbrokers are telling the truth. Nevertheless, the development of lie-detection technology was chiefly motivated by the promise of use by police in identifying (and excluding) suspects, and soon thereafter its potential for actual courtroom employment was recognized. The possibility of such use was stifled early on, however, for in 1923, in *Frye v. United States*,[17] the United States Court of Appeals for the District of Columbia held that the proffered lie-detection methods (William Moulton Marston's machine, in fact) had not yet achieved that level of general acceptance within the relevant scientific community

[16] On the history of lie-detection technology, see Ken Alder, *The Lie Detectors: The History of an American Obsession* (New York: Free Press, 2007); Kerry Segrave, *Lie Detectors: A Social History* (Jefferson, NC: McFarland & Co., Inc., 2003); Paul V. Trovillo, "A History of Lie Detection," *Journal of Criminal Law and Criminology*, vol. 29 (1939), pp. 848-881.

[17] 293 F. 1013 (D.C. Cir. 1923).

to justify its courtroom admissibility. Even apart from issues about lie-detection, *Frye*'s "general acceptance" standard held sway as the test for the admissibility of scientific or expert evidence in most federal and state courts for seventy years. And, more specifically, *Frye* established the principle and the precedent by which lie-detection evidence was generally prohibited from use, again both in federal and state courts.

The traditional blanket exclusion of lie-detection evidence is still the prevailing rule,[18] but there are signs that it is at least slightly weakening. New Mexico generally permits traditional polygraph evidence,[19] and a number of state and federal courts have eliminated the traditional per se exclusion of lie-detection evidence and testimony in favor of a somewhat more flexible and case-specific approach that takes into account the reliability of the particular methods used, the use for which the evidence is being offered, and the risk, in context, of excess confusion or prejudice.[20]

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[18] See David L. Faigman *et al.*, *Modern Scientific Evidence: The Law and Science of Expert Testimony* (Eagan, MN: Thomson/West, 2011), §40; Paul C. Gianelli & Edward J. Imwinkelreid, *Scientific Evidence* (San Francisco, CA: LexisNexis, 4th ed., 2007), §8.04; Robert J. Goodwin & Jimmy Gurulé, *Criminal and Forensic Evidence* (New Providence, NJ: Matthew Bender, 3rd ed., 2009), pp. 246-280; *State v. Blank*, 955 So. 2d 90, 131 (La. 2007); *Bennett v. Commonwealth*, 511 S.E. 2d 439 (Va. App. 1999); *State v. Domicz*, 907 A.2d 395 (N.J. 2006). Even jurisdictions with a per se rule of exclusion, however, often permit the use of such evidence under stipulation by all parties. *Dumicz*, *ibid.*

[19] N.M. R. Evid. §11-707; *State v. Dorsey*, 539 P.2d 204 (N.M. 1975).

[20] See *United States v. Benavidez-Benavidez*, 217 F.3d 720 (9th Cir. 2000); *United States v. Gilliard*, 133 F.3d 809 (11th Cir. 1998); *United States v. Cordoba*, 104 F.3d 225 (9th Cir. 1997); *United States v. Pulido*, 69 F.3d 102 (7th Cir. 1995); *United States v. Posado*, 57 F.3d 428 (5th Cir. 1995); *United States v. Henderson*, 409 F.3d 1293 (11th Cir. 2005); *United States v. Piccinonna*, 885 F.2d 1529 (11th Cir. 1989); *United States v. Galbreth*, 908 F. Supp. 877 (D.M.M. 1995); *State v. Porter*, 698 A.2d 739, 769 (Conn. 1997).

The softening of the traditional absolute ban on lie-detection evidence appears to be a function of two factors. First, the technology is improving. Even apart from issues relating to neuroscience and other new and different technologies, technological improvements in the traditional polygraph, the direct descendant on the Keeler machine created in the 1930s, have made lie-detection more accurate, especially in the hands of increasingly well-trained polygraph examiners.[21] And, second, it has become increasingly recognized that the required level of accuracy should vary with the use to which the evidence is being put.[22] It is one thing to say, as all American courts do say, that polygraphs are not sufficiently accurate to support a criminal conviction and consequent deprivation of liberty under the "proof beyond a reasonable doubt" standard that governs the prosecution's burden in a criminal case. But it is something else to say, for example, that a defendant whose alleged alibi has been supported by a polygraph examination should be prohibited from offering the results of that examination in the course of trying to prevent a criminal conviction (or lessen a sentence) and a loss of his freedom.[23] Much the same applies, although not as dramatically, to the use of lie-detection results in civil cases, where typically the plaintiff's burden is to establish his case by a preponderance of the evidence, and not by proof beyond a reasonable doubt.

Despite these inroads, however, the prevailing rule and practice, as noted above, is still one of exclusion, whether it be as a result of a *per se* rule of exclusion or the de facto persistent

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[21] See *Commonwealth v. Duguay*, 720 N.E.2d 458, 463 (Mass. 1999).

[22] See *United States v. Crumby*, 895 F. Supp. 1354 (D. Ariz. 1995).

[23] See *Rupe v. Wood*, 93 F.3d 1434, 1437 (9th Cir. 1996).

exclusion under a case-by-case determination. This general rule or practice of exclusion appears to be based on three considerations. The first is simple inaccuracy or unreliability.[24] The modern polygraph may be more accurate than its predecessors, but it may still not be accurate enough. The second is the possibility that subjects can be trained to use various countermeasures and thus "fool" the machine and the examiner, thereby increasing the degree of inaccuracy and unreliability.[25] And the third, which may well be the dominant reason, is the fear that jurors and judges will overvalue the accuracy of lie-detection, thus giving the technology more weight than it deserves, even if it does deserve some weight.[26]

II. New and Newer Technologies

Although traditional lie-detection technology is becoming increasingly accurate, recent years have seen the development of quite different and allegedly even more precise and reliable methods of testing veracity.   Functional magnetic resonance imaging (fMRI) examination is now the most prominent of these new advances, and constitutes the principal subject of this chapter, but by no means does it stand alone.[27]

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[24] See Jed S. Rakoff, "Science and the Law: Uncomfortable Bedfellows," *Seton Hall Law Review*, vol. 38 (2008), pp. 1379-1393.

[25] See *United States v. Cordoba*, 194 F.3d 1053 (9th Cir. 1999); Office of Technology Assessment, *Scientific Validity of Polygraph Testing* (Washington, D.C.: United States Congress, 1983), ch. 6.

[26] *State v. Shively*, 999 P.2d 952, 958 (Kan. 2000).

[27] See Sarah E. Stoller & Paul Root Wolpe, "Emerging Neurotechnologies for Lie Detection and the Fifth Amendment," *American Journal of Law & Medicine*, vol. 33 (2007), pp. 359-375.

Promoted by the popular television show *Lie to Me*, which aired from 2009 to 2011, one modern alternative to the lie-detection machine is the analysis by trained experts of facial expressions (or, more accurately, micro-expressions), bodily movements, speech patterns, and various other forms of externally observable behavior. Although the analysis of facial micro-expressions resembles the methods that lay people have long used to determine veracity, especially to the extent that they rely on non-verbal cues, proponents claim that the modern methods are scientifically validated, and that those with the proper training can distinguish the liar from the truth-teller with impressive consistency.[28]

Other modern approaches to lie-detection tend to be less behavioral and more physiological. Periorbital thermography, for example, measures the temperature around the eyes, based on the premise that periorbital temperature is reliable measure of the rate of blood flow around the eyes, and that this rate is an especially sensitive measure of stress and thus of deception.[29] Other methods focus more directly on the physiological reactions of the brain to deception. Near-infrared spectroscopy, for example, measures the optical properties of brain tissue, properties that have been shown to vary with stress level and other correlates of

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[28] Paul Ekman, *Telling Lies: Clues to Deceit in the Marketplace, Politics, and Marriage* (New York: W.W. Norton, rev. ed., 2009); Paul Ekman & Maureen O'Sullivan, "From Flawed Self-Assessment to Blatant Whoppers: The Utility of Voluntary and Involuntary Behavior in Detecting Deception," *Behavioral Sciences & Law*, vol. 24 (2006), pp. 673-686.

[29] See Ioannis Pavlidis, Norman Eberhardt, & James A. Levine, "Seeing Through the Face of Deception," *Nature*, vol. 415 (2002), p. 35; Ioannis Pavlidis & James A. Levine, "Thermal Image Analysis for Polygraph Testing," *IEEE Engineering in Medicine and Biology Magazine*, vol. 21 (2002), pp. 56-64; P.Tsiamyrtzis et al., "Imagine Facial Physiology for the Detection of Deceit," *International Journal of Computer Vision*, vol. 71 (2007), pp. 197-214.

deception.[30] And electroencephalography, sometimes referred to as "brain fingerprinting," measures at comparatively low cost (at least compared to a functional magnetic resonance imaging, although not as much when compared to the traditional polygraph) the electrochemical emissions of the brain, in particular brain wave P300, in response to various stimuli. It is used primarily to evaluate claims of knowledge or ignorance rather than deceptive intent as such, and is similarly claimed to be reliable in distinguishing those who have knowledge consistent with guilt, for example, from those who do not.[31]

Most of the contemporary attention has not been on the foregoing methods, however, but instead on the use of functional magnetic resonance imaging – fMRI – to detect detection. Insofar as certain regions of the brain are activated more in lying than in truth-telling, examining the extent to which those regions have more oxygenated hemoglobin under conditions of deception holds out the promise of a method of lie-detection more reliable than

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[30] See Scott C. Bunce, et al., "Detecting Deception in the Brain: A Functional Near-Infrared Spectroscopy Study of Neural Correlates of Intentional Deception," *SPIE Proceedings* 5769, vol. 24 (2005), http://dx.doi.org/10.1117/12.600601; Xiao-Su, et al., "fNIRS-based Online Deception Decoding," *Journal of Neural Engineering*, voo. 9 (2012), http://doi:10.1088/1741-2560/9/2/026012; F. Tian, et al., "Functional Near-Infrared Spectroscopy to Investigate Hemodynamic Responses to Deception in the Prefrontal Cortex," *Brain Research* 1303 (December 15, 2009), pp. 120-130.

[31] See Lawrence A. Farwell & Sharon S. Smith, "Using Brain MERMER to Detect Knowledge Despite Efforts to Conceal," *Journal of Forensic Science*, vol. 46 (2001), pp. 135-143; Anna Caterina Merzagora, et al., "Time-Domain Analysis of EEG during Guilty Knowledge test: Investigation of Epoch Extraction Criteria," *Proceedings of IEEE Engineering, Medical, and Biological Sciences Conference*, 2007, pp. 1302-1305; Andre A. Moenssens, "Brain Fingerprinting – Can It Be Used to Detect the Innocence of Persons Charged with a Crime?", *University of Missouri-Kansas City Law Review*, vol. 70 (2002), pp. 891-919.

those that have preceded it.[32] But it is important to note that little about fMRI lie-detection is different in kind from the various methods of which it is a successor. Lay perceptions notwithstanding, brains do not "light up" when engaged in some but not other tasks, and fMRI scans do not take pictures of brains, at least not in the ordinary person's understanding of "picture."[33] And they certainly do not "read minds." Rather, an fMRI scan measures and then displays the physiological responses of certain parts of the body – parts of the brain, in this case -- to certain activities. Thus, fMRI treats the brain as a body part whose emanations under

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[32] The literature is huge and growing. Among the more recent contributions, with an emphasis on those that survey earlier work, are Nobohito Abe, "How the Brain Shapes Deception," An Integrated Review of the Literature," *Neuroscientist*, vol. 17 (2011), pp. 560-574; Nobuhito Abe, *et al,*, "Deceiving Others: Distinct Neural Responses of the Prefrontal Cortex and Amygdala in Simple Fabrication and Deception with Social Interactions," *Journal of Cognitive Neuroscience*, vol. 19 (2007), pp. 287-295; Shawn E. Christ, *et at.*, "The Contributions of Prefrontal Cortex and executive Control to Deception: Evidence from Activation Likelihood Estimate Meta-Analyses," *Cerebral Cortex,* vol. 19 (2009), pp. 1557-1566; Matthias Gamer *et al.*, "Covariations Among fMRI, Skin Conductance, and Behavioral Data During Processing of Concealed Information," *Human Brain Mapping*, vol. 28 (2007), pp. 1287-1301; Georgio Ganis & Julian Paul Keenan, "The Cognitive Neuroscience of Deception," *Social Neuroscience*, vol. 4 (2009), pp. 465-472; A.A. Karim, et al., "The Truth About Lying: Inhibition of the Anterior Prefrontal Cortex Improves Deceptive Behavior," *Cerebral Cortex*, vol. 20 (2010), pp. 205-213; Daniel Langleben, "Detection of Deception with fMRI – Are We There Yet?," *Legal & Criminological Psychology*, vol. 13 (2008), pp. 1-9; Daniel A. Langleben & Frank M. Pattilio, "The Future of Forensic Functional Brain Imaging," *Journal of the American Academy of Psychiatry & Law*, vol. 36 (2008), pp. 502-504; George T. Monteleone, et al., "Detection of Deception Using fMRI: Better than Chance, But Well Below Perfection," *Social Neuroscience*, vol. 4 (2009), pp. 528-538; Jennifer Maria Nuñez, "Intentional False Responding Shares Neural Substrates with Response Conflict and Cognitive Control," *Neuroimage*, vol. 25 (2005), pp. 267-277; Joseph R. Simpson, "Functional MRI Lie Detection: Too Good to be True,?" *Journal of the American Academy of Psychiatry and Law*, vol. 36 (2008), pp. pp. 491-498; Paul R. Wolpe, et al., "Emerging Neurotechnologies for Lie-Detection: Promises and Perils," *American Journal of Bioethics*, vol. 10 (2010), pp. 40-48; D Wu, *et al.*, "Neural Correlates of Evaluations of Lying and Truth-Telling in Different Social Contexts," *Brain Research*, vol. 1389 (2011), pp. 115-124.

[33] See Adina L. Roskies, "Are Neuroimages Like Photographs of the Brain,?" *Philosophy of Science*, vol. 74 (2007), pp. 860-872.

certain conditions may reveal certain forms of behavior, just like the capillaries around the eyes, the heart that beats at a faster or slower rate, the lungs that breathe more or less rapidly, and the pores that produce a higher or lower rate of perspiration. In that sense, measuring brain activity during deception bears important similarities to measuring the activity of the heart, the lungs, and the apocrine glands during deception. Thus, if fMRI holds out hope for a more reliable method of detection deception, it is in its accuracy and degree of reliability, and in the precision of its focus on certain regions of the brain, rather than because it enables examiners to "see" something that has never before been observed, and not because there is something about brain activity that makes it in some way more genuine or authentic than other physiological manifestations or correlates of mental activities.

III. A Closer Look at fMRI Lie-Detection

Identifying the continuity between fMRI lie-detection and the earlier and alternative lie-detection technologies is important precisely because it rebuts the widely-held lay belief that fMRI represents an entirely new window into mental activities. That fMRI deception detection is less different from other methods than is often believed, however, does not mean that fMRI methods cannot be more precise, more accurate, more reliable, and more sophisticated in numerous ways than earlier methods of lie-detection, and it is precisely such claims that have made fMRI lie-detection the primary locus for current debates about the admissibility of lie-detection generally in American courts.[34]

[34] The literature specifically on the legal aspects of fMRI lie-detection is also vast and growing. Among the more comprehensive contributions are Henry T. Greely & Judy Illes, "Neuroscience-Based Lie Detection: The Urgent Need for Regulation," *American Journal of Law & Medicine*,

The basic theory of fMRI lie-detection is easily stated. If certain regions of the brain are activated (or more activated) when engaged in deceptive activity than when being truthful, then testing the relevant region or regions for such activation can identify the neural correlates of deceptive behavior, and, conversely, the neural correlates of truthful behavior. Although the ability to localize the brain regions that produce deceptive behavior (or many other varieties of behavior) is what is claimed to set fMRI methods apart from almost all others, the basic principle is still that certain measurable physiological responses -- in this case a particular region's increase in blood oxygenization – correlate with deceptive behavior. And if this is in fact so, then identifying those physiological responses can be probative on the question whether the subject is lying or telling the truth.

The forgoing is a highly oversimplified and abbreviated summary of the basic theory of fMRI lie-detection, but whether the theory is empirically grounded is another matter entirely. And thus we have seen published reports of numerous studies attempting to determine the extent of the reliability of fMRI in identifying deception.[35] Many of these studies have been sponsored or supported by the two principal for-profit companies seeking to market fMRI lie-detection

vol. 33 (2007), pp. 377-431; Charles N.W. Keckler, "Cross-Examining the Brain: A Legal Analysis of Neural Imaging for Credibility Impeachment," *Hastings Law* Journal, vol. 57 (2006), pp. 509-556; Joëlle Anne Moreno, "The Future of Neuroimaged Lie Detection and the Law," *Akron Law* Review, vol. 42 (2009), pp. 717-737; Michael S. Pardo, "Neuroscience Evidence, Legal Culture, and Criminal Procedure," *American Journal of Criminal Law*, vol. 33 (2006), pp. 301-337; Frederick Schauer, "Neuroscience, Lie-Detection, and the Law," *Trends in Cognitive Sciences*, vol. 14 (2010), pp. 101-103; Frederick Schauer, "Can Bad Science Be Good Evidence? Neuroscience, Lie Detection, and Beyond," *Cornell Law Review*, vol. 95 (2010), pp. 1191-1220; Leo Kittay, Note, "Admissibility of fMRI Lie Detection: The Cultural Bias Against 'Mind Reading' Devices," *Brooklyn Law Review*, vol. 72 (2007), pp. 1351-1399.

[35] *Op. cit.* notes 15, 32.

services – Cephos Corp. and No Lie MRI, Inc. And many of the studies, some independent of Cephos or NoLie but some not, have been published in peer-reviewed scientific journals. The aim of these studies has been to establish the rate of accuracy and degree of reliability in using fMRI scans to sort truthful from deceptive behavior, with the typical experimental method being for the researcher to instruct subjects to be truthful or not, and then to examine by scanning the neural activity associated with the respective behaviors. The more sophisticated experiments attempt to avoid the specific instruction to lie, but instead create conditions in which subjects in a stimulus group have an incentive to lie while subjects in a control group have no such incentive. Across all of the experimental designs, however, what the results show, and how confident we can be in what they show, are the sources of the now-considerable controversy over the use of fMRI to detect deception, and it is to these methodological controversies that I now turn.

IV. The Question of Accuracy

The goal of all the experiments that have been undertaken to date has been to establish the level of accuracy, and the reliability in producing that level, of fMRI as a deception-identifying methodology. Even the methodology's most enthusiastic proponents, however, do not claim anything near perfection. It is obvious that even with the best foreseeable methods some statements identified by their neural indicators as deceptive will in fact be truthful, and that some that are indicated as truthful will be in reality deceptive.[36] Postponing until the next

[36] It is worthwhile emphasizing that any lie-detection method purports to distinguish statements made with a belief in their truth from statements made with a belief in their falsity, rather than attempting to distinguish statements that are in fact true from statements that are in fact false.

section questions about experimental validity, the existing published studies claim an accuracy rate for fMRI methods in sorting honesty from deception as somewhere between 70% and slightly over 90%, depending on the study and depending on how the study is interpreted.[37] For purposes of comparison and calibration, this should be compared to the rates for the traditional polygraph and other non-fMRI methods, which range from 70% to 87%, although a few studies report lower rates and some even claim accuracy levels that are a bit higher.[38] Thus, the 2003 National Academy of Sciences report on the polygraph found (based on previous studies) a specific-incident (as opposed to screening) accuracy rate of between 87% and 89%, but warned that for various reasons these figures likely overstate actual accuracy.[39] The American Polygraph Association's own figures are also in the 85% to 87% accuracy range.[40] Thus, it is widely accepted that traditional methods are accurate at a level well above chance, but in general even the most enthusiastic proponents of traditional methods do not put the

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What is being measured is a state of mind and not the ground truth. Honest mistakes, while appropriately a major concern in the law and elsewhere, are not within the purview of methods aimed at identifying attempts to deceive.

[37] See Daniel D. Langleben, "Detection of Deception with fMRI: Are We There Yet?," *Legal and Criminological Psychology,* vol. 13 (2008), pp. 1-9; Anthony Wagner, "Can Neuroscience Identify Lies,?" in Michael S. Gazzaniga & Jed S. Rakoff, eds., *A Judge's Guide to Neuroscience: A Concise Introduction* (Santa Barbara, CA: University of California, Santa Barbara, 2010), pp. 13-25.

[38] See, for example, *United States v. Cordoba*, 991 F. Supp. 1199 (C.D. Cal. 1998) (noting a range in the studies of 48% to 90% and an average rate of 71%); Tsiamyrtzis, et al., *op. cit.* note 5 (reporting 87.2% successful classification rate for periorbital thermography); Pavlidis, et al., *op. cit.* note 5 (reporting Department of Defense test showing 80% accuracy for both traditional polygraph and periorbital thermography).

[39] National Research Council, *The Polygraph and Lie Detection* (Washington, D.C.: National Academies Press, 2003).

[40] See www/polygraph.org/section/resources/polygraph-validity-research.

accuracy rate at 90% or above. The promise of fMRI approaches is thus that they may, if not now then in the foreseeable future, secure a level of accuracy (or degree of reliability in achieving that accuracy) higher than any currently appearing to be possible by the use of more traditional polygraphic methods.

The accuracy rates that have emerged from the research are in one sense just numbers. That is, whether a given degree of accuracy is accurate enough, or whether the reliability of a given method is reliable enough, depends on the uses for which the information would be put. None of us, I hope, would sentence to life imprisonment someone only 80% likely to have committed the crime of which he is charged, but most of us would refuse to hire as a baby-sitter someone 80% likely to be a child molester.[41] In the context of courtroom use of lie-detection, therefore, two issues emerge. One is whether, in the context of a criminal trial, evidence plainly insufficient to support a criminal conviction should nonetheless be usable by a defendant in an attempt to prevent such a conviction. A defendant 80% likely to be lying in his claim of innocence will (or should) not be convicted and imprisoned on this evidence alone[42] under the existing "proof beyond a reasonable doubt" standard applicable to criminal trial in

[41] See Frederick Schauer & Richard Zeckhauser, "On the Degree of Confidence for Adverse Decisions," *Journal of Legal Studies*, vol. 24 (1996), pp. 27-52.

[42] In theory, evidence will be admitted even when presented by the prosecution in a criminal case as long as it makes some proposition (including the defendant's guilt) more likely with the evidence than without. Federal Rules of Evidence, Rule 401. There is a large difference between what is necessary for a single item of evidence to be admitted and what is cumulatively sufficient to establish guilt beyond a reasonable doubt. Nevertheless, worries about juror overvaluation of particular items of evidence, or about the prejudicial effect of particular logically relevant items of evidence (Rule 403) have the effect, in practice, of excluding a considerable amount of prosecution evidence in criminal cases that passes the minimal threshold of more likely with the evidence than without.

the Anglo-American legal system, but a defendant 80% likely to be telling the truth in his claim of innocence would seem to have offered evidence substantially undercutting proof of his guilt beyond a reasonable doubt.[43] As a result, most of the contemporary controversy, at least in the United States,[44] about the usability of lie-detection, whether by traditional polygraph or by fMRI or by anything else, is not about its use by prosecutors to prove a defendant's guilt, but about its potential use by defendants to support their alibis or other claims of innocence.[45] Such efforts by defendants, however, take place in the shadow of *United States v. Scheffer*,[46] in which the Supreme Court of the United States held, in the context of a criminal case in the military courts (where an absolute exclusion of polygraph evidence prevails), that the rule of absolute exclusion of polygraph evidence, even by a defendant attempting to establish his innocence, was not unconstitutional. That some practice is not unconstitutional, however, is not to say that it is mandatory, and thus the question remains open whether such exclusion is wise or sound as a matter of policy, whether empirically or normatively.

[43] The example is oversimplified in many ways, but one is that the accuracy rates of any method for identifying deception are rarely even close to identical to the accuracy rates for identifying truthfulness. That is, if a(1) is the accuracy of a conclusion that the subject was telling the truth, and a(2) is the accuracy of a conclusion that the subject was lying, there is no reason to believe that a(1) and a(2) must be the same, and in fact they rarely are.

[44] Notoriously, brain scans have been used in India to support criminal convictions. The principal case is described extensively in Dominique J. Church, Note, "Neuroscience in the Courtroom: An International Concern," *William and Mary Law Review*, vol. 53 (2012), pp. 1825-1854.

[45] As of this writing, the most recent of a number of thus-far unsuccessful attempts by defendants to use fMRI scans to support their claims of innocence is the Maryland trial of *State v. Smith*, the details of which were reported in *The Washington Post* on August 26, 2012.

[46] 523 U.S. 303 (1998).

Although the high stakes and high salience of criminal trials has made them the locus of much of the controversy about fMRI lie-detection, recognizing that the required rate of reliability varies with the consequences points to the possibility that different rates of reliability might be sufficient on other settings. One such setting is the civil trial, typically for damages, in which the plaintiff's burden of proof is ordinarily proof by a preponderance of the evidence. And so too in issues regarding child custody, employment discrimination, and many others, in which knowing that someone is, say, 80% likely to be telling the truth could well be understood as sufficient. That the use of fMRI deception detection methods are properly precluded from use by the prosecution in a criminal case, therefore, says less than some might believe about the desirability of their use for other purposes, especially by defendants in criminal cases.[47] If it is true that current accuracy rates are at least above 80%, and if it is true (and it may not be) that such accuracy rates survive potential counter-measures,[48] then denying to a defendant the

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[47] This is not to dismiss entirely the slippery slope fears of some critics. These critics (for example, Kanwisher, *op. cit.* note 12; Phelps, *op. cit.* note 12) appear to worry that allowing fMRI deception evidence by defendants in order to avoid criminal conviction and incarceration will lead to the general acceptability of such methods, which will in turn lead to its acceptability when used by prosecutors (as in the India case noted above, *op. cit.* note 44). But although it is true that the formal rules of evidence generally do not distinguish for admissibility evidence offered by the prosecution in a criminal case from evidence offered by the defendant, there are some rules that explicitly do make such a distinction (Rule 404 of the Federal Rules of Evidence, for example), and in practice admissibility criteria vary considerably depending on whether evidence is offered by prosecution or defense. Recognizing that slippery slope arguments are irreducibly empirical (see Frederick Schauer, "Slippery Slopes," *Harvard Law Review*, vol. 99 (1985), pp. 361-383), the question is then of how many defendants should be deprived of the ability to present defense-relevant evidence, and at what cost for that deprivation, in order to prevent some small but not non-existence probability of prosecution use in the future.

[48] On the possibility that countermeasures may substantially lower existing reported accuracy rates, and with support for that possibility, see Giorgio Ganis, *et al.*, "Lying in the Scanner: Covert Countermeasures Disrupt Deception Detection by Functional Magnetic Resonance Imaging," *Neuroimage*, vol. 55 (2011), pp. 312-319.

ability to use such relatively accurate information in an attempt to establish his innocence and thus avoid imprisonment presents issue of justice at least as pressing as guarding against the possibility of use of such evidence by the prosecution.

V. On the Validity of the Existing Research

Experiments can establish the accuracy rates for various methods of identifying deception, but that is so only if the experiments are valid. And thus there has been considerable controversy about the validity of the experiments purporting to establish the accuracy rates just described.

Some of the objections go to the question of external or ecological validity.[49] As with other behavioral experiments, the fMRI experiments on deception have commonly been performed on undergraduates or on members of the population at large whose willingness to participate raises questions about the extent to which they are representative of actual people involved in real situations in which important stakes turn on what they say or do. Insofar as the subject pool in many of the experiments thus differs in characteristics and incentives from the pool of people whose behavior we are actually and ultimately interested in, and insofar as the artificial experimental conditions also vary from many high-stakes real-world situations, so the objection goes, the experimental results using an unrepresentative pool under unrepresentative

[49] Some researchers treat external and ecological validity as the same thing, while others understand them differently. Insofar as the question here is whether laboratory results can be used to predict non-laboratory real-world behavior, ecological validity is probably the more accurate term.

conditions pool cannot provide the basis for legitimate assertions about rates of accuracy with respect to the behavior of a different pool of people engaged in relevantly different tasks.[50]

Such objections are far from frivolous, but they are hardly specific to fMRI or even to the question of deception more generally. If fMRI deception studies are invalid because they are performed on undergraduates or unrepresentative volunteers and performed in settings involving lower stakes than are present in real forensic settings, then so too are most of the studies we now have on, just to draw on examples from the psychological research now increasingly used in legal contexts, the reliability (or not) of eyewitness identification, the reliability of witness memory, the processes that juries use to make decisions, and much else. With few exceptions, the studies pertaining to all of these subjects employ similarly arguably unrepresentative subject pools with similarly arguably unrepresentative subject incentives in order to make predictions about the behavior of people generally in real-world non-laboratory settings. Thus, these objections to fMRI deception studies are largely a subset of the common complaint about behavioral studies – they are performed on undergraduates in artificial settings or they are performed with volunteers whose very act of volunteering makes them atypical of the population at large -- and thus not valid for drawing conclusions about the general population in non-artificial settings.

Not surprisingly in light of the longstanding frequency of the complaint just noted, there has been research directed to exactly this point, and it tends to support the ecological validity of

[50] See Jordan T. Cohen, "Merchants of Deception:: The Deceptive Advertising if fMRI Lie Detection Technology," *Seton Hall Legislative Journal*, vol. 35 (2010), pp. 157-197, at p. 185.

many studies using undergraduate subjects under low-stakes circumstances to draw conclusions about people in general in higher-stakes settings. That is, these methodological studies have concluded that well-designed experiments using student subject pools with low incentives can be reliable in predicting the behavior of people in general in real-world situations.[51] The predictions are often not perfect, but the results and the ecological validity should not be surprising. Undergraduates are, after all, people (the opinions of their instructors and sometimes their parents notwithstanding), and a well-designed experiment will provide for those people incentives that have been shown again to parallel the incentives of the real world. Thus, insofar as some critics have quarreled with the existing studies on the grounds that they are not performed on the kinds of people likely to be lying or telling the truth in real forensic settings, the objections go to almost all of the psychological research increasingly used in the legal system, and, in addition, are objections largely falsified by the existing methodological research. The situation may of course be different with respect to fMRI lie-detection, for there have been no studies explicitly and specifically directed at the correlation between laboratory fMRI deception studies and real-world deception. But the fact that there is data rebutting many of the common complaints about laboratory experiments on undergraduates or

[51] See Craig A. Anderson *et al.*, "Research in the Psychology Laboratory: Truth or Triviality," *Current Directions in Psychological Science*, vol. 8 (1999), pp. 3-9; Leonard Berkowitz & Edward Donnerstein, "External Validity is More than Skin Deep: Some Answers to Criticism of Laboratory Experiments," *American Psychologist*, vol. 37 (1982), pp. 245-257; Arie W. Kruglanski, "The Human Subject in the Psychology Experiment: Fact and Artofact," in Leonard Berkowitz, ed., *Advances in Experimental Social Psychology*, vol. 8 (New York: Academic Press, 1975), pp. 101-147. A valuable overview of the issues is Marilynn Brewer, "Research Design and Issues of Validity," in Harry T. Reiss & Charles M. Judd, eds., *Handbook of Research Methods in Social and Personality Psychology* (Cambridge, UK: Cambridge University Press, 2000), pp. 3-39.

volunteers in low-stakes scenarios at least suggests that many of what are essentially the same complaints in the fMRI case may be substantially overblown.

Much more serious is the objection based not on the alleged lack of ecological validity but on the claimed absence of construct validity. Because experimental subjects in deception research have traditionally been instructed to lie or tell the truth, it is said, the experiments tell us only about instructed lies and not about real lies.[52] The instructed lie is an example of following an instruction rather than of attempting to deceive, so the concern goes, and thus the behaviors whose neural correlates are measured in an experimental setting are simply not the behaviors we are actually interested in.

Although it is true that an instructed lie is different in obvious ways from a real lie, the question is not that different from the question about ecological or external validity. That is, an experiment lacking in what is often called construct identity is valid to the extent that the non-identical construct used in the experiment can in fact predict the admittedly different real world events that it is purporting to measure. Measuring people's existing ability at mathematics as a way of predicting their ability to learn French, for example, plainly lacks construct validity in the sense of there being very different things that are measured. If it turned out, however, that mathematical ability correlated with the ability to learn French, then experiments done on mathematical ability would be valid for purposes of predicting French ability just to that extent. Similarly, therefore, if it were to be determined (and it has not yet

[52] See Kamila E. Sip, *et al.*, "Detecting Deception: The Scope and Limits," *Trends in Cognitive Sciences*, vol. 12 (2008), pp. 48-53.

been so determined, nor has it yet been rejected) that the willingness to tell an instructed lie correlated with the willingness to tell a real lie, then the lack of identity between the former and the latter would not be fatal to the capacity to make predictions about the latter based on experiments on the former.[53]

Implicit in the foregoing discussion of both ecological and construct validity is the view that both external validity and construct validity are matters of degree. Scientists often resist this conclusion, but the resistance is based on confusing the entirely appropriate standards for scientific publication with the standards of epistemic progress. A result with statistical significance at only, say, the .15 level would (and should) not normally be sufficient for scientific publication or even for scientific assertion by scientists, but such a result might nevertheless be far from spurious or random. Similarly, when there is a non-spurious correlation between the conditions of an experiment and the decidedly non-identical conditions of what we are trying to determine, it is right for scientists, *qua* scientists, to treat some relationship is not having been established, but the correlation might well still be sufficient for other purposes.

Recently, and especially in the work of Joshua Greene and his colleagues,[54] there have been studies in which the subjects have real incentives to tell real lies, and such studies, while far

[53] Some weak and indirect support for the hypothesis suggested in the text comes from Georgio Ganis *et al*., "Neural Correlates of Different Types of Deception: An fMRI Investigation," *Cerebral Cortex*, vol. 13 (2003), pp. 830-836, finding a correlation between different types of deception using different regions of the brain.

[54] Joshua D. Greene & Joseph M. Paxton, "Patterns of Neural Activity Associated with Honest and Dishonest Moral Decisions," *Proceedings of the National Academy of Sciences*, vol. 106 (2009), pp. 12506-12511.

from conclusive, hold out the potential for transcending some of the common objections on grounds of construct validity.[55] But even apart from these more recent studies, even the studies using instructed lies or having other seeming defects of construct validity might still be of some use, once again depending on the nature of their use and the degree of confidence that might, as an undeniably normative matter, flow from that context.

A final objection to many of the existing studies is that they have invalidly offered group-level or population-level[56] conclusions in support of individual-level uses.[57] This is by no means a new objection, nor, again, is it unique to fMRI detection studies.[58] The use of population-level data to provide evidence in individual cases is a highly prominent and hotly debated issue with respect to, for example, the use of epidemiological data to prove causation in cases involving toxic pollutants, dangerous pharmaceuticals, and other potentially hazardous substances.[59] Because the epidemiological data is about a population, so it is argued, it cannot provide

[55] And note also, with respect to ecological validity, 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," *Radiology*, vol. 238 (2006), pp. 679-688.

[56] Sometimes also called ecological or macro-level conclusions. See Ana V. Diez Roux, "The Study of Group-Level Factors in Epidemiology: Rethinking Variables, Study Designs, and Analytical Approaches," *Epidemiological Review*, vol. 26 (2004), pp. 104-111.

[57] See Wagner, *op. cit.* note 37.

[58] See, for example, Andrew See, "Use of Human Epidemiology Studies in Proving Causation," *Defense Counsel Journal*, vol. 67 (2000), pp. 478-487.

[59] See See, *ibid.*; Melissa Moore Thomson, "Causal Inference in Epidemiology: Implications for Toxic Tort Litigation," *North Carolina Law Review*, vol. 71 (1992), pp. 247-292. Compare Mark Parascandola, "What is Wrong with the Probability of Causation,?" *Jurimetrics*, vol. 39 (1998), pp. 29-44; James Robins & Sander Greenland, "The Probability of Causation under a Stochastic Model for Individual Risk," *Biometrics*, vol. 45 (1989), pp. 1125-1138.

evidence as to whether the probabilistically extant causation for the population existed in any given individual case. And there are related debates in sociology and political science, where again the issues about inferring individual or small group attributes from large-group properties are widely and strenuously debated, often in the context of voting behavior.[60]

Whether in the context of toxic torts or patterns of voting or fMRI studies, however, the objection is complex and sometimes misdirected, and even at its core has been subject to powerful critiques.[61] Thus, if some substance is 70% likely, based on population studies, to cause a certain kind of cancer, then that fact is relevant (albeit not conclusive) not only on the question of whether a given individual who has been exposed to the substance is likely to contract that form of cancer, but also to the question whether, *absent other evidence*, the cancer identified in a particular individual has been caused by exposure to that substance. Even more importantly, however, the inference to individual attributes from population-level studies of those attributes may not run afoul of the ecological inference problem when causation is not at issue. To take the trite example from basic statistics, if we know that half the balls in the population of 1000 balls in an urn are striped, then it is not fallacious to assess the probability that a randomly selected ball will be striped at .5. Obviously this example, like the entire

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[60] Compare, for example, Gary King, *A Solution to the Ecological Inference Problem* (Princeton, NJ; Princeton University Press, 1997), with David A. Freedman, *et at.*, "Ecological Regression and Voting Rights," *Evaluation Review*, vol. 15 (1991), pp. 659-817. See also Leo A. Goodman, "Some Alternatives to Ecological Correlation," *American Journal of Sociology*, vol. 64 (1959), pp. 610-625; W, Phillips Shively, "Ecological Inference: The Use of Aggregate Data to Study Individuals," *American Political Science Review*, vol. 63 (1969), pp. 1183-1196.

[61] See, for example, Timothy Williamson, *Knowledge and Its Limits* (Oxford: Oxford University Press, 2000); Alex Broadbent, "Epidemiological Evidence in Proof of Specific Causation," *Legal Theory*, vol. 17 (2011), pp. 237-278.

discussion in the previous several paragraphs, is egregiously over-simplified. But the basic point is only that the question of whether, when, and how we can infer individual attributes or individual probabilities from population-level data is a hotly debated question throughout social science and natural science methodology. It is a mistake to assume that no such problems exist for the studies on fMRI identification of deception, but it is also a mistake to assume that one side of these debates is so uncontroversially correct that the population-level studies should be dismissed out of hand. Moreover, even those who are most skeptical of ecological inference are concerned primarily with the strength of the inference and not its existence. In other words, few would say that ecological inferences are without any evidentiary value, even if the degree of that value is, because of the problems of ecological inference, frequently overstated. And if such inferences have at least some evidentiary value, then we are back to the question of just how much evidentiary value is needed for what purposes in what contexts, which is exactly the kind of partially necessarily (partly) normative question that cannot be answered by the science alone. Population-level studies showing, say, that some region of the brain is more likely to be activated under conditions of deceptive behavior than under conditions of honesty will thus provide some evidence as to whether an individual with that form or degree of brain activation has been deceptive or truthful, but whether that evidence is enough may well vary with what turns on the decision for which the evidence is to be used.

VI. Who Own Science?

It should thus be clear that the existing debates about the quality of the science supporting the claims of fMRI-based lie-detection are heavily laden with normative and institutional design claims often hiding behind the cover of evaluative adjectives. The MacArthur Neuroscience Project's guide for judges, for example, concludes that "no relevant published data unambiguously answers whether fMRI-based neuroscience methods can detect lies at the individual-instance level."[62] Whether that statement is true, however, depends not only on a slightly contested notion of what it is for a study to be "published" in our modern electronic world, but also, and far more importantly, on the evaluative variables of "relevant" and "unambiguously." Similarly, and more commonly, it is often claimed that there is no "solid" or "definitive" or "reliable" or "compelling" or "certain" support for the conclusion that fMRI methods can identify deception.[63] If such adjectives are taken to refer to and characterize conclusions that are beyond serious debate, the claims are almost always true. But if such adjectives are taken to represent the Bayesian more-likely-with-the-evidence-than-without standard, then the claims are almost always false. In between, however, is where the action is, and it is here that we not only need to specify just how relevant, how unambiguous, how solid, how certain, how definitive, or how reliable, but also to make clear where the appropriate point on the scale of relevancy comes from, and in what context or contexts it ought to be used.

Seeing the problem in this way exposes what may be the real issue. A recent issue of the Association for Psychological Science's *Observer* described a colloquium on the topic of "Who

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[62] Wagner, *op. cit.* note 37.

[63] See, for example, Kanwisher, *op. cit.* note 12 ("compelling").

Owns Science?"[64] The focus of the symposium and the article was on diversity, but the same question might be asked about a different topic. More specifically, the question can be asked about who is to decide on the appropriate uses of science, and who is to determine the appropriate normative and evaluative standards by which to evaluate the suitability for use of scientific conclusions. It is common for scientists to believe that scientists should control the uses of their work, and it is easy to applaud the sense of social responsibility the leads scientists to worry that their output will be misused or distorted. But it is also important to recognize that questions about the uses of science are not themselves scientific questions, or ones in which the training and norms of science necessarily give scientists a comparative advantage. Scientists can (and should) tell us, for example, that we could save, say, 4300 lives per year by reducing the speed limit on interstate highways from 65 to 55, but whether to do so against competing claims of economic and social efficiency is a political and normative question in which scientists should be interested, but in which their views cannot themselves be produced exclusively by the science. And scientists can tell us what it would cost to develop and distribute a drug that would reduce the suffering of *n* number of people to *x* extent, but, again, whether to spend the money to produce that result is not a scientific judgment. Getting the science right is a necessary condition for doing good public policy, and for that task scientists are of course essential, but getting the science right cannot be a sufficient condition, at least as long as it remains fallacious to attempt to derive an ought from an is.

[64] Douglas Medin *et al.*, "Who Owns Science?," *APS Observer*, vol. 25(6) (July/August 2012), pp. 11-14.

And so too with respect to the use of research on fMRI lie-detection. It is true that the degrees of accuracy and of reliability of any method of assessing deception are scientific questions and not legal or philosophical ones. And the same holds true of the size of the correlation, if any, between the experiments actually conducted and the real-world behaviors that those experiments are designed to predict. But with respect to all of these questions – the questions of accuracy and of reliability and of validity – whether some degree is good enough for some purpose is a question involving the full panoply of inputs into what we might call legal policy. Law is of course everyone's concern, and the answer to these profound questions as to what standards law should use in determining, say, who is telling the truth and who not should no more be left exclusively to lawyers and judges than to scientists. But we make a valuable first step in answering some very difficult questions by recognizing that how law is used is not just for the lawyers, and similarly that how science is used is not just for the scientists.

VII. Compared to What?

In the context of lie-detection, and much else besides, the "compared to what?" question looms large. Determining whether witnesses, litigants, suspects, and the like are telling the truth has been a concern of the legal system long before there were polygraphs, to say nothing of brain scans. As noted in the introduction to this paper, the oath was originally designed to serve this purpose, but its reliability as a guarantor of truth is, now, highly questionable. It may serve the purpose of reminding witnesses of the solemnity of the occasion and of the possibility of a prosecution for perjury, but neither of these purposes seems to have had much impact on the ubiquitous phenomenon of the lying witness.

Without the perceived threats of eternal damnation[65] or of prosecutions for perjury, determining the veracity of witnesses is left largely to judges and juries, assisted, in theory, by the process of cross-examination. But we know that cross-examination works rather less well in real courtrooms than on television, and although cross-examination may be effective in exposing inaccuracies and inconsistencies in a witness's account, it may have less force against the practiced or insistent liar than many people believe. And when faced with contradictory accounts by witnesses not toppled by cross-examination, the task of evaluating comparative veracity falls largely to the jury, or, when there is no jury, to the judge serving as trier of fact. Yet in performing this task, juries and even judges hardly inspire confidence. They rely on numerous alleged indicators of deceptiveness for which there is little empirical support, such as looking down or away from the jury, or blinking frequently, or failing to display confidence.[66] And they frequently use empirically spurious and/or morally or legally impermissible factors – race, ethnicity, and nationality, for example – as proxies for veracity. It is not surprising that the

[65] The word "perceived" is important here. I have no idea whether telling a lie under oath will sentence me to burn in hell forever, but I have a much better sense of the number of people who worry about the possibility, and it is the perception rather than the ground truth that matters in this context.

[66] Steven Penrod & Brian Cutler, "Witness Confidence and Witness Accuracy: Assessing their Forensic Relation," *Psychology, Public Policy, & Law*, vol. 1 (1995), pp. 817-845. See also Jeremy Blumenthal, "A Wipe of the Hands, a Lick of the Lips: The Validity of Demeanor Evidence in Assessing Witness Credibility," *Nebraska Law Review*, vol. 72 (1993), pp. 1157-1192; Geoffrey R. Loftus, "What Can a Perception-Memory Expert Tell a Jury?," *Psychonomic Bulletin & Review*, vol. 17 (2010), pp. 143-48.

research on veracity-determination by laypeople indicates that they are rarely much better than random in determining who is telling the truth and who is not.[67]

When faced with such a battery of obstacles to accurate determination by judges or juries about whether witnesses are telling the truth, the question then to be asked about any lie-detection technology, including but not limited to the traditional polygraph, is whether it represents an improvement over what now exists. And if we understand the question in those terms, then it becomes somewhat harder to justify not only the pervasive skepticism about the forensic use of fMRI lie-detection, but indeed also the traditional and still largely persisting exclusion of even traditional polygraph evidence.

VIII. The Problem of Overvaluation

Although the likely empirical superiority of technological lie-detection over the collection of urban legends and superstitions that reside in jurors' heads should not be especially controversial, much of the traditional exclusion is based on a fear that jurors and possibly even judges will substantially overvalue the capacity of lie-detection technology, thus leading them to give it disproportionate weight and to think it even more reliable than it is. Even if it is somewhat reliable, so it is said, it is not nearly as reliable as jurors are likely to think it is, and thus the remedy of mandated underuse (as measured against the baseline of its intrinsic probative value) is thought appropriate to guard against likely overuse.

[67] See references *op. cit.* note 7.

The concerns about overvaluation pervade the law of evidence,[68] and explain many of the prohibitions on the use of, for example, hearsay, character evidence, reputation, and secondary evidence of the content of writings. And they explain why expert testimony must meet a higher threshold of probative value than non-expert evidence. In all of these cases, the worry is that juries and perhaps even judges will be influenced by extraneous or impermissible factors in treating certain kinds of evidence as worth more than they really are, and hence the exclusions or the higher hurdles for admissibility.

The fears of overvaluation surface with considerable frequency in the context of neuroscientific evidence generally, and with brain scan evidence about veracity in particular.[69] When juries are shown what they believe to be a picture of a brain, and when it appears to be a vivid color depiction of a brain in action, they are inclined, so it is said, to treat its indications as somewhere between highly persuasive and dispositive, and at least as substantially more persuasive than the actual weight such evidence should have or the actual reliability that the methods would suggest. Thus, so the argument goes, juries are so likely to overuse and

[68] The overvaluation concerns, as well as concerns about the concerns, are well-presented in Richard D. Friedman, "Minimizing the Jury Over-Valuation Concern," *Michigan State Law Review*, vol. 2003 (2003), pp. 967-986. See also Neil Vidmar & Valerie P Hans, *American Juries: The Verdict* (Amherst, NY: Prometheus Books, 2007); Neil Vidmar & Shari Seidman Diamond, "Juries and Expert Evidence," *Brooklyn Law Review*, vol. 66 (2001), pp. 1121-1180.

[69] See, for example, Gazzaniga, *op. cit.* note 12, at pp. 413, 415.

overweight fMRI evidence that it ought not to be used, even if it in fact has some weight and some value in determining credibility.[70]

There are important studies that support the support the position that fMRI scans, when shown to juries, will lead juries (or the experimental subjects who are proxies) to give the information provided by the scan substantially more weight than they would give the exact same information when presented in verbal or less seemingly photographic graphic form.[71] What appears as a picture of a brain, and for some people as a picture of a brain lighting up, thus adds additional and intrinsically worthless value to the actual information provided by the scan, and does so more than various other graphic but not-photographic ways of presenting such material.

There are additional studies, some done by the same researchers, that indicate that the problem the problem of overvaluation can be substantially ameliorated by appropriate

[70] See Walter Sinnott-Armstrong *et al.*, "Brain Images as Legal Evidence," *Episteme*, vol. 5 (2008), pp. 359-373; See also Deena Skolnick Weisberg, *et al.*, "The Seductive Allure of Neuroscience Explanations," *Journal of Cognitive Neuroscience*, vol. 20 (2008), pp. 470-477.

[71] David P. McCabe & Alan D. Castel, "Seeing is Believing: The Effect of Brain Images on Judgments of Scientific Reasoning," *Cognition*, vol. 107 (2008), pp. 343-352. See also Jessica R. Gurley & David K. Marcus, "The Effects of Neuroimaging and Brain Injury on Insanity Defenses," *Behavioral Sciences and Law*, vol. 26 (2008), pp. 85-97; David P. McCabe *et al.*, "The Influence of fMRI Lie Detection Evidence on Juror Decision-Making," *Behavioral Sciences and the Law*, vol. 29 (2011), pp. 566-577. The worry about juror (and judge) overvaluation or misinterpretation is at the heart of the skeptical (about the current admissibility of fMRI lie-detection evidence) conclusions in J.R.H. Law, "Cherry-Picking Memories: Why Neuroimaging-Based Lie Detection Requires a New Framework for the Admissibility of Scientific Evidence under FRE 702 and Daubert," *Yale Journal of Law and Technology*, vol. 14 (2011), pp. 1-65.

cautionary instructions, warnings, and framing.[72] Thus, if jurors are explicitly told that this is not a picture of a brain, that the brain is not lighting up, and that the reliability of the scan to show deception is far less than perfect, they may well become somewhat more likely to give the evidence the value it deserves, and no more. More importantly, however, it is not clear that the inflation of probative value brought about by a picture as opposed to words or a non-realistic chart or graph is any greater than the inflation brought about by pictures in general.[73] Visual imagery, and especially photographic visual imagery, has an independent effect, controlling for content,[74] and that effect exists across a vast range of contents and contexts.[75] So although it is clear that an image of a brain will distort and inflate the content that the image presents, or that it will be more persuasive than identical information presented without a brain image, the same phenomenon of inflation occurs with a realistic looking image of the scene of a crime, with a picture of the body of a murder victim, or with a video-taped reconstruction of an automobile accident. Perhaps it would be better if the legal system avoided the use of photographs entirely, but it does not, believing instead that a picture is worth a thousand words, even if many of the words are not true. The precise question to be asked about fMRI evidence therefore, is not whether they produce inflated value or inflated

[72] McCabe, *et al.*, *op. cit.* note 68.

[73] See Feigenson, *op. cit.* note 13, at p. 249.

[74] See, for example, in the context of moral judgments, Elinor Amit & Joshua D. Greene, "You See, the Ends Don't Justify the Means: Visual Imagery and Moral Judgment," *Psychological Science*, vol. 23 I2012), pp. 861-868.

[75] A good overview of the research is Neal Feigenson, "Visual Evidence," *Psychonomic Bulletin & Review*, vol. 17 (2010), pp. 149-154.

persuasion, which they plainly do, but whether the inflated value they produce is greater than the inflated value produced by the visual evidence that the legal system routinely admits.[76] Thus far the only study aimed at this question seems to point to the contrary,[77] and consequently it is not inappropriate to conclude that there exists as of this writing no evidence that the inflation in persuasion produced by what appear to be pictures of scans is in any greater or more persuasive or more distorting than the inflation in persuasion or inflation in pseudo-information that is produced by numerous other items of visual evidence that juries have been routinely permitted to use for generations.

IX. The *Daubert* Problem

That the claims of overvaluation of neuroscience evidence are empirically debatable is, at least as a matter of American law, somewhat beside the point. As noted above, worries about overvaluation explain much of why for generations expert evidence must clear a higher hurdle than seemingly more direct evidence. The fear that experts, or people who look and act like experts, will be more persuasive to juries than their actual expertise would justify has long been used to undergird a requirement that expert evidence be more than just something that makes

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[76] Or by the non-visual evidence the legal system routinely admits. It is becoming increasingly well known that eyewitness observation is far less reliable than most people think and thus routinely overvalued by judges and juries. The question about the value inflation of neuroscience evidence is thus, again, not about whether there is such value inflation, for of course there is, but whether it is greater than the value inflation of eyewitness observation, personal recollection, and most of the other evidence that constitutes the basis for the Anglo-American trial process.

[77] N.J. Schweitzer *et al*., "Neuroimages as Evidence in a Mens Rea Defense: No Impact," *Psychology, Public Policy, and Law*, vol. 17 (2011), pp. 357-393.

the truth of some proposition more (or less) likely with the evidence than without, which is the baseline rule for non-expert evidence.[78]

This concern with overvaluation was heightened in the Supreme Court's decision in 1993 in *Daubert v. Merrell Dow Pharmaceuticals, Inc.*[79] Spurred largely by a fear about the so-called junk science that was motivating large verdicts in mass tort cases, the Supreme Court erected a barrier to expert and scientific evidence that required that such evidence, especially in the scientific context, meet the standards of science itself. Whether the Supreme Court understood the nature of scientific inquiry correctly has been debated ever since *Daubert* was decided,[80] but it is clear that, contrary to my suggestions above, scientific evidence will be admissible in court only if it comes with the kinds of credentials that scientists would themselves employ.

As long as *Daubert* remains the law, and it is clearly the law in all federal courts and indirectly (by persuasion and not authority in the strict sense) in most state courts, the

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[78] Federal Rules of Evidence, Rule 401.

[79] 509 U.S. 579 (1993). The *Daubert* principles now include the refinements in two subsequent cases, *General Electric Co. v. Joiner*, 522 U.S. 136 (1997), and *Kumho Tire Co., Ltd. v. Carmichael*, 526 U.S. 137 (1999).

[80] See, for example, Ronald J. Allen, "Expertise and the *Daubert* Decision," *Journal of Criminal Law and Criminology*, vol. 84 (1994), pp. 1157-1175; Susan Haack, "Federal Philosophy of Science: A Deconstruction – And a Reconstruction," *New York University Journal of Law & Liberty*, vol. 5 (2010), pp. 394-435; Susan Haack, "An Epistemologist in the Bramble-Bush: At the Supreme Court with Mr. Joiner," *Journal of Health Politics, Policy & Law*, vol. 26 (2001), pp. 217-248; Adina Schwartz, "A 'Dogma of Empiricism' Revisited: *Daubert v. Merrell-Dow Pharmaceuticals, Inc.* and the Need to Resurrect the Philosophical Insight of *Frye v. United States*," *Harvard Journal of Law & Technology*, vol. 10 (1997), pp. 149-237.

exclusion of fMRI evidence on veracity is likely to continue. The *Daubert* standards essentially defer to scientists on what scientific evidence should be admitted into evidence. The *Daubert* factors include the production of known error rates and peer review publication, and these standards may well already have been satisfied. And so too with at least some of the other *Daubert* factors. But one of the *Daubert* factors, carried on from the earlier *Frye* test[81] that *Daubert* seemingly replaced, is that it is relevant to the determination of admissibility that a method has not achieved "widespread" acceptance with the relevant scientific community. As noted above, and throughout this article, with few exceptions the community of neuroscientists has yet to accept the validity of fMRI lie-detection when measured by scientific standards, and on thus on the law as it now exists, this lack of widespread acceptance may well be sufficient for some time to keep fMRI-based evidence of deception or truthfulness well outside of the courtroom.

X. Conclusion

Lie-detection represents a curious anomaly in the contemporary debates and commentary about the forensic use of scientific and technical methods and expertise. With respect to many of these methods – handwriting analysis, voiceprints, tool marks, bite marks, and even fingerprints – the tenor of the times is to cast appropriate doubt on methods of identification and investigation long taken for granted.[82] Some of these methods are largely spurious, and

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

[82] See, for example, National Research Council, Committee on Identifying the Needs of the Forensic Science Community, *Strengthening Forensic Science in the United States: A Path Forward* (Washington, DC: National Academies Press, 2009); Michael J. Saks, "Explaining the

most of them, even if possessing some value, remain untested and likely less accurate and less reliable than has long been believed. Prevailing commentary and post-*Daubert* legal developments have thus been to highlight these doubts, and to show that the legal system has largely over-valued the contributions such methods can make.

With respect to lie-detection, however, the situation is in some respects exactly the opposite. Fingerprints, bite marks, voiceprints, handwriting analysis, tool marks and the like are routinely admitted at trial even though their accuracy and reliability remains dubious and often untested. Lie-detection, however, is routinely excluded, even though the rigor of its testing, while often flawed, surpasses that of the methods traditionally and routinely admitted, and even though its accuracy appears to be at least as great as that of many of the commonly admitted methods. While the array of traditional forensic identification techniques appears to be less valuable than the legal system has long assumed, it is possible that lie-detection is more valuable than the legal system has long assumed.

That the current state of affairs is anomalous says nothing about how the anomaly should be reconciled, if at all. Perhaps the legal system's skepticism about lie-detection, whether polygraphic or neuroscientific, is justified, and should be joined by an equivalent skepticism about the various other methods it has routinely accepted. But once we take seriously the "compared to what?" question, and once we understand the almost entirely unscientific and

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Tension between the Supreme Court's Embrace of Validity as the Touchstone of Admissibility of Expert Testimony and Lower Court's (Seeming) Rejection of Same," *Episteme*, vol. 5 (2008), pp. 329-342; Michael J. Saks & Jonathan J. Koehler, "The Coming Paradigm Shift in Forensic Identification Science," *Science*, vol. 309 (2005), pp. 892-895; Jason M. Tangen, *et al.*, "Identifying Fingerprint Expertise," *Psychological Science*, vol. 22 (2011), pp. 995-997.

untested faith, even by scientists, in the worries about juror and judge over-valuation, we might at least take seriously the possibility that it is the wholesale exclusion of scientific evaluation of veracity that may be in need of correction. As the techniques of fMRI detection of deception become more rigorously tested and more accurate, it will become increasingly difficult for the legal system to avoid confronting the issue more directly.