

10-1-2014

Evidence of Lies and Rules of Evidence: The Admissibility of fMRI-Based Expert Opinion of Witness Truthfulness

William A. Woodruff

Follow this and additional works at: <http://scholarship.law.unc.edu/ncjolt>Part of the [Law Commons](#)

Recommended Citation

William A. Woodruff, *Evidence of Lies and Rules of Evidence: The Admissibility of fMRI-Based Expert Opinion of Witness Truthfulness*, 16 N.C. J.L. & TECH. 105 (2014).Available at: <http://scholarship.law.unc.edu/ncjolt/vol16/iss1/5>

This Article is brought to you for free and open access by Carolina Law Scholarship Repository. It has been accepted for inclusion in North Carolina Journal of Law & Technology by an authorized administrator of Carolina Law Scholarship Repository. For more information, please contact law_repository@unc.edu.

**EVIDENCE OF LIES AND RULES OF EVIDENCE:
THE ADMISSIBILITY OF fMRI-BASED EXPERT OPINION OF
WITNESS TRUTHFULNESS**

*William A. Woodruff**

Neuroscientists are exploring intriguing technology that some claim will revolutionize the jury's search for truth. Functional Magnetic Resonance Imaging ("fMRI") seeks to correlate brain activity with cognitive function. Current research with regard to lie detection indicates that laboratory studies have achieved accuracy rates in excess of 90% in identifying deception and verifying truth in study participants. But how likely will this new technology be useful in the context of the rules governing the impeachment and rehabilitation of witnesses at trial? Does the new technology meet the reliability standards demanded of expert scientific opinion? Has the neuroscience community generally accepted the reliability of fMRI as a lie detector? Will professional opinions on witness truthfulness actually help the jury in its fact-finding role? Or, will it confuse and confound the jury in its essential task of reaching a verdict?

Judicial scrutiny and scholarly commentary to date has focused on the reliability of expert opinion and whether the neuroscience community has generally accepted this new application of fMRI with little consideration of other evidentiary requirements that may limit expert opinion testimony of witness truthfulness. This Article identifies thirteen impediments to admissibility and presents them under five major categories: (1) the regulation of impeachment and rehabilitation of witnesses; (2) the requirement that expert testimony help the jury to understand the

* Professor of Law, Campbell University School of Law, Raleigh, NC. An earlier version of this paper was presented to the International Conference On Neuroscience In European and North American Case Law, European Center for Law, Science and New Technologies, Università Deglie Studi di Pavia, Milan,

evidence or decide a fact in issue; (3) the rule requiring expert testimony to be based upon reliable principles and methods; (4) the requirement in some jurisdictions that novel scientific principles be generally accepted by the relevant scientific community; and (5) the balancing of unfair prejudice and probative value of the opinion testimony.

TABLE OF CONTENTS

I.	INTRODUCTION	108
II.	EVIDENCE OF LIES: FUNCTIONAL MAGNETIC RESONANCE IMAGING	114
III.	RULES OF EVIDENCE: THE CRUCIBLE OF THE COURTROOM	120
IV.	RULES OF EVIDENCE: ATTACKING AND SUPPORTING CREDIBILITY	125
	<i>A. Timing: Impeach First, Rehabilitate Second</i>	<i>127</i>
	<i>B. Form: Rehabilitation Must Meet the Impeachment</i>	<i>128</i>
	<i>C. Application: Impeaching and Rehabilitating with fMRI</i>	<i>129</i>
	1. <i>Capacity</i>	131
	2. <i>Character</i>	132
	3. <i>Contradiction</i>	138
	4. <i>Inconsistency</i>	140
	5. <i>Bias</i>	141
	6. <i>Deliberate Deception</i>	143
V.	RULES OF EVIDENCE: EXPERT OPINION TESTIMONY	154
	<i>A. Rule 702: The Relevant and Reliable Standard</i>	<i>155</i>
	<i>B. Evidence of Lies: Judicial Scrutiny of fMRI Expert Opinion on Truthfulness</i>	<i>159</i>
	<i>C. Evidence of Lies: Analyzing Expert Opinion of Truthfulness</i>	<i>168</i>
	1. <i>The Qualifications of the Expert Witness</i>	170
	2. <i>The Appropriateness of the Subject Matter</i>	171
	3. <i>Help the Trier of Fact</i>	172
	4. <i>Sufficient Facts and Data</i>	196
	5. <i>Reliable Principles and Methods</i>	198

6. <i>Reliable Application of Reliable Principles and Methods</i>	229
D. <i>Frye: The General Acceptance Standard</i>	230
VI. RULES OF EVIDENCE: BALANCING PROBATIVE VALUE VERSUS PREJUDICIAL EFFECT	233
A. <i>Probative Value: Unilateral Examinations</i>	236
B. <i>Probative Value: Specificity of the Opinion</i>	239
C. <i>Probative Value: Reliability</i>	240
D. <i>Prejudicial Effect: Bolstering Credibility</i>	241
E. <i>Prejudicial Effect: Unreliability</i>	242
F. <i>Prejudicial Effect: Confusing the Issues</i>	243
VII. RULES OF EVIDENCE: CRIMINAL DEFENDANT’S RIGHT TO OFFER EVIDENCE	244
VIII. CONCLUSION	249

I. INTRODUCTION

Despite media hype¹ and at least one company still offering scientific expert testimony on whether a witness is telling the truth,² proponents of functional magnetic resonance imaging (“fMRI”) as a lie detector have failed in three attempts to admit the new technology as evidence of witness truthfulness³ at trial. A federal district judge in Tennessee,⁴ a New York state trial judge,⁵

¹ See *Brains on Trial* (PBS television broadcast Sept. 11 & 18, 2013), available at <http://brainsontrial.com/>; *Your Cheating Brain*, BBC NEWS (Nov. 12, 2001), <http://news.bbc.co.uk/2/hi/science/nature/1651974.stm>; *Lie Detection: Making Windows in Men's Souls*, THE ECONOMIST (July 8, 2004), http://www.economist.com/node/2897134/print?Story_ID=2897134; Steve Silberman, *Don't Even Think About Lying*, WIRED (Jan. 2006), <http://www.wired.com/wired/archive/14.01/lying.html>; *Why do People Cheat? Dateline Explores (Part 5)*, NBC NEWS (Dateline NBC television broadcast, May 8, 2009), http://www.msnbc.msn.com/id/30645239/ns/dateline_nbc-health_stories/; *Mind Reading*, CBS NEWS (June 28, 2009), <http://www.cbsnews.com/videos/mind-reading-50073711>; Adi Narayan, *The fMRI Brain Scan: A Better Lie Detector?*, TIME (July 20, 2009), <http://www.time.com/time/health/article/0,8599,1911546-1,00.html>; Virginia Hughes, *Science in Court: A Head Case*, NATURE (Mar. 17, 2010), <http://www.nature.com/news/2010/100317/full/464340a.html>.

² NO LIE MRI, INC., <http://noliemri.com> (last visited Mar. 13, 2014). Until early in 2013, a second company, Cephos Corp., <http://www.cephoscorp.com> (last visited Mar. 7, 2014), also offered truth verification services using fMRI.

³ With the exception of the emerging theory that fMRI can “decode” memory and reveal something that is in the subject’s memory but is either beyond the conscious recall of the subject or the subject denies having the memory, proponents of fMRI do not claim to be able to address witness credibility in its larger sense. See *infra* notes 594–95 and accompanying text. There are, however, other potential forensic applications of fMRI technology. Professor Hank Greely identifies five areas where fMRI may be relevant in legal proceedings: (1) detecting lies; (2) detecting memory or recognition; (3) detecting pain; (4) detecting bias; and (4) detecting consciousness. Henry T. Greely, *Mind Reading, Neuroscience, and the Law* in A PRIMER ON CRIMINAL LAW AND NEUROSCIENCE 120–49 (Stephen J. Morse & Adina Roskie, eds., 2013). While bias may relate directly to witness credibility, the research into this area is just beginning. No one has suggested that fMRI is scientifically reliable or valid in detecting bias.

⁴ *United States v. Semrau*, No. 07–10074, 2010 WL 6845092 (W.D. Tenn. June 1, 2010). The Magistrate Judge’s Report and Recommendation to exclude

and a Maryland state trial judge⁶ all rejected fMRI-based expert testimony on witness truthfulness.

The hypothesis underlying fMRI as a lie detector is that telling the truth is the natural or normal response of the brain and one would not expect to see increased activity over and above the normal background level of brain activity. Lying, however, requires the person to first recall the truth, then suppress the truth while creating a lie that might plausibly fit the objective facts, and finally, verbalize the falsehood. This increased neural activity demands more energy. To supply the energy demand, more oxygenated blood is directed to those regions of the brain processing the lie. This relative difference in energy demand, called the blood oxygenation level-dependent (“BOLD”) differential by neuroscientists, is detectable by an fMRI scan. Comparing the BOLD differential between subjects known to be telling the truth with those deliberately lying allows researchers to hypothesize that an increased BOLD response in certain regions of the brain when the subject is answering questions is an indication of deception.

Three recent cases have dealt with the admissibility of expert opinion of truthfulness based on fMRI testing.⁷ The defendant in a federal prosecution in Tennessee for Medicaid and Medicare billing fraud, Dr. Lorne Semrau, underwent fMRI scanning by Dr. Stephen Laken, an fMRI researcher and president of a company that provided forensic fMRI lie detection services.⁸ Dr. Laken conducted scans that addressed whether Dr. Semrau intended to defraud the government when he “upcoded” Medicare and Medicaid reimbursement claims by filing claims under a procedure code that reimbursed at a higher rate than the code for the

the fMRI-based expert testimony was adopted by the district judge and affirmed on appeal. *United States v. Semrau*, 693 F.3d 510 (6th Cir. 2012).

⁵ *Wilson v. Corestaff Servs., L.P.*, 28 Misc. 3d 425 (N.Y. Sup. Ct. 2010).

⁶ Memorandum Opinion and Order, *Maryland v. Smith*, No. 106589C (Montgomery Cty., Cir. Ct., M.D. Oct. 3, 2012).

⁷ See *infra* notes 8–30 and accompanying text.

⁸ *Semrau*, 2010 WL 6845092, at *1–4.

procedure actually performed.⁹ Dr. Laken also attempted to determine whether he knew it was improper to seek separate reimbursement for an included procedure that was not to be billed separately.¹⁰ Dr. Laken concluded that Dr. Semrau was truthful during his fMRI scan when he denied the intent to defraud and when he claimed he did not know that billing separately for the included procedure was impermissible.¹¹ Dr. Semrau's counsel then notified the government of his intent to introduce fMRI-based expert opinion testimony to support Dr. Semrau's truthfulness as a witness.¹² The government moved to exclude the proffered expert testimony.¹³ The magistrate judge, after hearing testimony from Dr. Laken, two government experts, and reviewing scientific and legal literature on the subject, found that expert opinion testimony of truthfulness based on fMRI was not sufficiently reliable and was too prejudicial to put before the jury.¹⁴ Based on the magistrate judge's recommendation, the district judge excluded Dr. Laken's opinion testimony. The Sixth Circuit affirmed the district Court's ruling.¹⁵

The second court to consider the admissibility of fMRI-based expert testimony on truthfulness was a New York state trial court hearing a case involving a plaintiff-employee alleging employer retaliation for reporting an incident of sexual harassment in the workplace.¹⁶ The plaintiff, who worked for a company that supplied temporary office workers, complained to her employer that a fellow employee sent her sexually explicit photos over an office fax machine.¹⁷ After she reported the sexual harassment by

⁹ *Id.*

¹⁰ *Id.*

¹¹ *Id.* at 5–6.

¹² *Id.* at 1.

¹³ *Id.*

¹⁴ See *infra* notes 185–255 and accompanying text for a discussion of the magistrate judge's ruling on the admissibility of the fMRI evidence offered by Dr. Semrau.

¹⁵ *United States v. Semrau*, 693 F.3d 510 (6th Cir. 2012).

¹⁶ *Wilson v. Corestaff Servs., L.P.*, 28 Misc. 3d 425, 426 (N.Y. Sup. Ct. 2010).

¹⁷ *Id.*

her co-worker, she was not assigned out for other temporary work.¹⁸ She sued for retaliation.¹⁹ In support of her claim of retaliation, plaintiff offered the testimony of another employee, who reportedly heard plaintiff's supervisor say that plaintiff would not be assigned other temp work because she complained of sexual harassment.²⁰ To bolster the credibility of the supporting witness, the witness underwent fMRI scanning by Dr. Laken.²¹ As in *Semrau*, the plaintiff notified the defendant that she was prepared to offer fMRI-based expert testimony that the witness was being truthful when he reported hearing the supervisor disclose his plan to retaliate against plaintiff.²²

Because this was in New York state court, the trial judge applied the *Frye*²³ general acceptance standard and excluded the testimony without an evidentiary hearing.²⁴ In granting the defendant's motion to exclude the expert's opinion, the court noted that "even a cursory review of the scientific literature demonstrates that the plaintiff is unable to establish that the use of the fMRI test to determine truthfulness or deceit is accepted as reliable in the relevant scientific community."²⁵

The third case in which fMRI based expert testimony on witness truthfulness was offered was the re-trial of Gary James Smith, a former Army Ranger who was convicted of killing his roommate, Michael McQueen, Jr.²⁶ After the conviction at his first

¹⁸ *Id.*

¹⁹ *Id.*

²⁰ *Id.*

²¹ *Id.*

²² *Id.*

²³ *Frye v. United States*, 293 F. 1013 (D.C. Cir. 1923). In *Frye*, the defendant offered evidence that he had taken and passed the "lie detector" test that was the predecessor to the modern polygraph. In excluding the examiner's testimony that the defendant was telling the truth, the court held that novel scientific evidence was not admissible until it had achieved general acceptance by the relevant scientific community. *Id.*

²⁴ *Corestaff Servs., L.P.*, 28 Misc. 3d at 426–28.

²⁵ *Id.* at 428.

²⁶ Memorandum Opinion and Order at 5–6, *Maryland v. Smith*, No. 106589C, (Montgomery Cty, MD, Oct. 3, 2012). The conviction in the first trial was

trial was reversed, Smith again claimed that McQueen committed suicide.²⁷ To support this argument he underwent fMRI scanning by Frank Haist, a consultant for No Lie fMRI.²⁸ Haist was prepared to testify that Smith was being truthful when recounting the fact that McQueen died of a self-inflicted wound and that Smith did not shoot him.²⁹ The trial judge, after considering testimony by experts from both sides, reviewing scientific literature submitted by the parties, and hearing from each side's expert, excluded the fMRI-based expert opinion on witness truthfulness because "it is clear . . . that the use of fMRI to detect deception and verify truth in an individual's brain has not achieved general acceptance in the scientific community."³⁰

Much of the legal literature on fMRI as a lie detector has dealt primarily with the reliability of the underlying scientific theory and whether expert testimony based on fMRI is admissible under Federal Rule of Evidence 702 ("Rule 702") or the *Frye* general acceptance standard.³¹ Little has been written on how this novel

reversed because the trial judge excluded defense evidence on the victim's state of mind. *Smith v. State*, 423 Md. 573 (Md. Ct. App. 2011).

²⁷ Memorandum Opinion and Order at 6, *Maryland v. Smith*, No. 106589C, (Montgomery Cty, MD, Oct. 3, 2012).

²⁸ Michael Laris, *Debate on Brain Scans as Lie Detectors Highlighted in Maryland Murder Trial*, WASH. POST (Aug. 26, 2012), http://www.washingtonpost.com/local/crime/debate-on-brain-scans-as-lie-detectors-highlighted-in-maryland-murder-trial/2012/08/26/aba3d7d8-ed84-11e1-9ddc-340d5efb1e9c_print.html.

²⁹ *Id.*

³⁰ Memorandum Opinion and Order at 5–6, *Maryland v. Smith*, No. 106589C, (Montgomery Cty, MD, Oct. 3, 2012) (copy on file with the author). Smith was convicted at the second trial but has not raised the exclusion of the fMRI evidence on appeal. Brief of the Appellant at 1–3, *Smith v. Maryland*, (No. 1832) 2013 WL 6004017 (June 27, 2013).

³¹ See, e.g., Daniel D. Langleben, *Detection of Deception with fMRI: Are We There Yet?*, 13 LEGAL AND CRIMINOLOGICAL PSYCHOL. 1 (2008); Elena Rusconi & Timothy Mitchener-Nissen, *Prospects of Functional Magnetic Resonance Imaging as a Lie Detector*, 7 FRONTIERS IN HUMAN NEUROSCIENCE 1, 3–4 (2013); Charles Adelsheim, *Functional Magnetic Resonance Detection of Deception: Great as Fundamental Research, Inadequate as Substantive Evidence*, 62 MERCER L. REV. 885, 905–08 (2011); Frederick Schauer, *Can Bad Science be Good Evidence? Neuroscience, Lie Detection, and Beyond*, 95 CORNELL L. REV. 1191,

scientific technique fits within the larger context of the regulation of evidence of witness credibility.³² This Article seeks to fill that gap in the literature and considers the admissibility of fMRI based expert opinion on witness truthfulness within the framework of the rules governing the impeachment and rehabilitation of witnesses, the admissibility of expert opinion testimony, as well as the criminal defendant's constitutional right to offer evidence that may otherwise be excluded by a rule of evidence.

Part II briefly explains MRI technology as it pertains to lie detection. Part III provides context for the debate over admissibility of fMRI opinion on truthfulness by reviewing the American tradition of assigning credibility decision to the jury. Part IV analyzes the rules governing the admissibility of expert opinion testimony on truthfulness and how they apply to fMRI-based opinion testimony that a witness lied or told the truth during an fMRI scan. Part V addresses the application of the rules regulating expert opinion testimony and considers whether the current state of the scientific research can satisfy either the relevant and reliable standard of Rule 702 or the *Frye* general acceptance standard followed by several state jurisdictions. Part VI explores whether fMRI-based expert opinion on witness truthfulness that clears the hurdles imposed by the impeachment and rehabilitation rules and the rules governing expert opinion can satisfy the probative value versus prejudicial effect balancing test of Federal Rule of Evidence 403 and state analogs. Part VII considers whether the Constitution provides the criminal defendant a right to offer fMRI-based opinion testimony on witness truthfulness even if one or more of the other rules of evidence excludes the testimony.

1192 (2010); Joseph R. Simpson, *Functional MRI Lie Detection: Too Good to be True?*, 36 J. AM. ACAD. PSYCHIATRY L. 491, 491 (2008); Laurence R. Tancredi & Jonathan D. Brodie, *The Brain and Behavior: Limitations in the Legal use of Functional Magnetic Resonance Imaging*, 33 AM. J. L. & MED. 271, 280–86 (2007); F. Andrew Kozel et al., *Detecting Deception Using Functional Magnetic Resonance Imaging*, 58 BIOLOGICAL PSYCHIATRY 605, 605 (2005).

³² See, e.g., Charles N.W. Keckler, *Cross-examining the Brain: A Legal Analysis of Neural Imaging for Credibility Impeachment*, 57 HASTINGS L. J. 509, 545–51 (2006).

Part VIII concludes that fMRI as a lie detector cannot yet satisfy the reliable and relevant standards of Rule 702 and it has not yet reached the level of general acceptance in the relevant scientific community to earn admission under *Frye*. It also concludes that the American tradition of assigning credibility determinations to the jury imposes additional burdens on proponents of fMRI lie detection that will further delay the day in which this technology is admitted in a jury trial. The obstacles imposed by the rules of evidence will, in turn, make the economic exploitation of the technology less likely and may hinder further research. This Article ultimately concludes that someday fMRI testimony on witness truthfulness may be admitted, but it will not be anytime soon.

II. EVIDENCE OF LIES: FUNCTIONAL MAGNETIC RESONANCE IMAGING

Magnetic resonance imaging (“MRI”) is the latest noninvasive imaging technology currently in use in medical science.³³ Unlike x-ray and other forms of medical imaging, MRI does not subject the patient to ionizing radiation. Using magnetic fields of different strengths to influence the alignment of hydrogen atoms in the body, the MRI scanner records the release of the energy stored by the hydrogen atoms’ single proton nucleus as it responds to the cycling magnetic fields. Processing the captured data through

³³ The first commercially available MRI scanners for medical imaging were marketed in the early 1980s. See RICHARD B. BUXTON, INTRODUCTION TO FUNCTIONAL MAGNETIC RESONANCE IMAGING (2d ed. 2009). For a succinct explanation that highlights the aspects most likely to influence evidentiary issues, see Henry T. Greely & Judy Illes, *Neuroscience-Based Lie Detection: The Urgent Need for Regulation*, 33 AM. J. L. & MED. 377 (2007). Other very readable sources of information on how fMRI works are Adina L. Roskies, *Brain Imaging Techniques*, in A PRIMER ON CRIMINAL LAW AND NEUROSCIENCE 37-74 (Stephen J. Morse & Adina L. Roskies eds., 2013); Tancredi & Brodie, *supra* note 31, at 27; Teneille Brown & Emily Murphy, *Through a Scanner Darkly: Functional Neuroimaging as Evidence of a Criminal Defendant’s Past Mental States*, 62 STAN. L. REV. 1119 (2010).

computer algorithms creates an image of the body part under examination.³⁴

Scientists have long known that increased brain activity demands more blood to the area of the brain engaged in the activity.³⁵ The interrelationship between brain activity, cerebral blood flow, and the metabolism of oxygen and glucose by the brain is the foundation of fMRI.³⁶ This foundation is based on two principles: (1) regions of the brain that are more active receive more oxygenated blood than regions of the brain that are less active; and (2) oxygenated blood and deoxygenated blood behave differently in a magnetic field because they have different magnetic resonance.³⁷

The oxygen-carrying hemoglobin molecules in the blood do not disrupt the MRI's magnetic field as the blood passes through it.³⁸ Once oxygen is taken up by the surrounding tissue as the brain draws upon this energy source to fuel its activity, however, the oxygen-depleted blood does disrupt the magnetic field and the MRI scanner captures this disruption.³⁹ By scanning a person's brain while that person is performing some cognitive task and capturing the magnetic resonance resulting from cerebral blood flow, cerebral blood volume, and cell metabolism, the MRI scanner can produce an image revealing which regions of the brain are more active while the task is being performed.⁴⁰ This BOLD signal allows scientists to locate the regions of the brain where the cognitive task under study is being performed.⁴¹ An fMRI scan taken before and during a cognitive task detects the relative

³⁴ See Langleben, *supra* note 31, at 2.

³⁵ See BUXTON, *supra* note 33, at 6.

³⁶ See *id.*

³⁷ See *id.* at 7.

³⁸ See Marcus E. Raichle, *An Introduction to Functional Brain Imaging in the Context of Lie Detection*, in USING IMAGING TO IDENTIFY DECEIT: SCIENTIFIC AND ETHICAL QUESTIONS, 3, 4 (Am. Acad. of Arts and Scis., 2009).

³⁹ See *id.*

⁴⁰ See Geoffrey K. Aguirre, *Functional Neuroimaging: Technical, Logical, and Social Perspectives*, 45 HASTINGS CTR. REP. S8, S9 (2014).

⁴¹ See *id.*

difference in the oxygenated blood in a given region of the brain and permits the construction of a graphic image of the BOLD responses associated with the brain state under study.⁴² While not a direct observation of neural activity, the BOLD signal is an indication of neural activity.⁴³

As it applies to lie detection, the theory is that when the subject is telling the truth, he is merely recalling facts from memory, a task that does not require particularly high levels of neural activity.⁴⁴ Lying, on the other hand, does require more neural activity because the person must suppress the truth while also constructing the lie.⁴⁵ This increased neural activity demands more energy.⁴⁶ To meet the energy demand, more oxygenated blood is provided to that portion of the brain engaged in the cognitive task.⁴⁷ To produce an image that represents the relative difference between the baseline or "truth" level of brain activity and the activity level when the subject is lying, the subject is told to respond to a series of questions truthfully during one scan and to respond to the same questions deceptively during a second MRI scan.⁴⁸ The data from the two scans is processed through a computer algorithm to produce a graphical image of the hemodynamics associated with the respective conditions.⁴⁹ The resulting images display the presence of oxygenated blood in the brain by assigning color to regions where the computer algorithms determined that the BOLD response was present.⁵⁰ The presence of more oxygenated blood in certain regions of the brain while the subject is answering

⁴² See *id.*

⁴³ Rusconi & Mitchener-Nissen, *supra* note 31, at 3–4.

⁴⁴ See Sean A. Spence, et al., *A Cognitive Neurobiological Account of Deception: Evidence from Functional Neuroimaging*, 359 PHIL. TRANSACTIONS OF THE ROYAL SOC'Y OF LONDON 1755, 1757 (2004).

⁴⁵ See *id.*

⁴⁶ See Sean A. Spence, *Playing Devil's Advocate: The Case Against fMRI Lie Detection*, 13 LEGAL & CRIM. PSYCHOL. 11, 12 (2008).

⁴⁷ See *id.*

⁴⁸ See *id.*

⁴⁹ See Aguirre, *supra* note 40, at S12–S13.

⁵⁰ See *id.* at S11.

questions is said to be indicative of deception.⁵¹ Conversely, the absence of the BOLD response in those brain regions associated with lying are said to verify the truthfulness of the subject's responses.⁵²

The final images produced by the scanner's computer, however, are not photographs or X-Rays of the brain processing a lie. Rather, they are a complex combination of technologies from the fields of physics, neurophysiology, cognitive neuroscience, statistics, computer science, and software development that seek to represent relatively small changes in blood flow and oxygen metabolism in the part of the brain under study.⁵³

The spatial resolution of the typical MRI scanner produces incredibly detailed anatomical images of tissue and body structures.⁵⁴ These images are most useful in the medical setting where physicians are looking for some structural abnormality, such as a tumor. In fMRI, however, the goal is temporal resolution, which is the change in metabolic activity over time.⁵⁵ As temporal resolution increases, spatial resolution decreases.⁵⁶ Thus, the "picture" of the BOLD response is not the clear, sharp image one might expect from an MRI scan seeking to identify anatomical structures or abnormalities. To be useful to the neuroscientist trying to determine whether a certain portion of the brain was activated while the subject was performing some cognitive task in the scanner, the raw data is cleaned up, background "noise" and artifacts are removed, spatial resolution is sharpened, signal data is averaged and then enhanced by computer algorithms to highlight the relatively slight BOLD response, and color is added to the

⁵¹ See Martha J. Farah et al., *Functional MRI-based Lie Detection: Scientific and Societal Challenges*, 15 NATURE REV. 123, 123 (2014). The most common brain regions to show activation during fMRI deception studies are the prefrontal cortex, the anterior cortex, and the parietal cortex. *Id.*

⁵² See *id.* at 123–24.

⁵³ See Brown & Murphy, *supra* note 33, at 1145.

⁵⁴ See Aguirre, *supra* note 40, at S10.

⁵⁵ See *id.* at S9–S10.

⁵⁶ See *id.* at S8–S9.

active voxels⁵⁷ to graphically display the relative strength of the BOLD response.⁵⁸ The resulting image is then overlaid onto an anatomical image of the brain so the colorful highlights representing the BOLD response are associated with a particular region of the brain.⁵⁹ Because the structural image is produced from an MRI scanning at one cubic millimeter voxel size and the BOLD image is produced from a three cubic millimeter voxel size, the BOLD image overlay and the structural image can never match exactly.⁶⁰ Because the different resolution of the MRI and fMRI scans makes precise alignment impossible, the MRI image of the brain onto which the computer enhanced image of the BOLD response is overlaid may be a scan of a “standard” brain and not the brain of the subject under study.⁶¹

Proponents of fMRI lie detection maintain that the BOLD response is a direct measurement of a completely involuntary physiological function directly related to the cognitive task of prevaricating.⁶² Compared to the polygraph, which measures physiologic functions thought to be related to stress that are

⁵⁷ See Aguirre, *supra* note 40, at S10. Voxels are volumetric pixels; essentially, three-dimensional pixels. These voxels typically measure 3mm x 3mm x 3mm in fMRI compared to the 1mm x 1mm x 1mm voxel size in MRI. The smaller voxel size in MRI contributes to the high quality of spatial resolution in structural scans. But they are too small to capture the hemodynamic change over time, hence the need for larger voxels in fMRI and the decrease in spatial resolution. *Id.*; see also, Giorgio Ganis, et al., *Lying in the Scanner: Covert Countermeasures Disrupt Deception Detection by Functional Magnetic Resonance Imaging*, 55 NEUROIMAGE 312, 314 (2011); Owen Jones, et al., *Brain Imaging for Legal Thinkers*, 2009 STAN. TECH. L. REV. 5, 8, 12 (2009).

⁵⁸ See Aguirre, *supra* note 40, at S9–S11.

⁵⁹ See *id.* at S12.

⁶⁰ See Roskies, *supra* note 33, at 63–65.

⁶¹ See Brown & Murphy, *supra* note 33, at 1145. See generally Aguirre, *supra* note 40, for a detailed explanation of the various steps needed to create the sort of fMRI BOLD image frequently displayed in the scientific literature, the popular media, and as exhibits to accompany expert testimony.

⁶² See Kozel et al., *supra* note 31, at 605; see also K. Luan Phan, et al., *Neural Correlates of Telling Lies: A Functional Magnetic Resonance Imaging Study at 4 Tesla*, 12 ACADEMIC RADIOLOGY 164, 170 (2005) (discussing the various sections of the brain associated with, and affected by lying).

assumed to be a product of lying,⁶³ the fMRI measures the cerebral blood flow, volume, and metabolism of the portion of the brain thought to be processing the lie and compares it with that same portion of the brain when the subject is telling the truth.⁶⁴ Thus, proponents argue, the fMRI image of the BOLD response is a more accurate and reliable indicator of truthfulness than the polygraph.

Irrespective of any accuracy advantage the BOLD response may have to the physiological phenomena measured by the polygraph, it is important to note that fMRI is not measuring actual neural activity directly. It is not capturing deception itself. It is merely capturing what researchers believe are the neural correlates of deception.⁶⁵ Like the polygraph, fMRI is looking at the shadow cast by deception and is not detecting lies in any direct sense. No current technology can directly distinguish between the neural activity of truth and the neural activity of deception.⁶⁶

The reliability of fMRI as a forensic tool to either detect deception or verify truth is very much an open question. Whether it is a more accurate screening device than the polygraph routinely used in law enforcement investigations, security and counterterrorism interrogations, or certain employment background checks, however, is beyond the scope of this Article. Rather, the concern this Article addresses is whether the technology is admissible to either impeach or support the credibility of a witness at trial. In this context, admissibility requires the evidence meet both the rules governing expert opinion testimony and those applicable to the impeachment and rehabilitation of witnesses.

⁶³ See NAT'L RESEARCH COUNCIL, *THE POLYGRAPH AND LIE DETECTION* 13 (Nat'l Acads. Press, 2003).

⁶⁴ See Daniel D. Langleben et al., *Brain Activity During Simulated Deception: An Event-Related Functional Magnetic Resonance Study*, 15 *NEUROIMAGE* 727, 731 (2002).

⁶⁵ See Spence, *supra* note 46, at 12.

⁶⁶ See Rusconi & Mitchener-Nissen, *supra* note 31, at 5.

III. RULES OF EVIDENCE: THE CRUCIBLE OF THE COURTROOM

The American jury trial is the reconstruction of a past event or incident.⁶⁷ The jurors are the historians trying to determine what actually happened on the day in question. Witnesses with personal knowledge of various parts and pieces of the story tell the jury, under oath, what they saw, heard, felt, touched, or otherwise experienced. These percipient witnesses testify to their recollection of the facts. The jury must decide which witnesses to believe and what weight to give the testimony received in order to find the facts of the case. Determining the facts is the core function of the American jury.⁶⁸

When it will assist the jury in their task of historical reconstruction, witnesses who do not have personal knowledge of any of the historical facts but who have opinions based on the application of scientific, technical, or other specialized knowledge to the facts, information, or evidence from the event are permitted to testify to their opinions. These expert witnesses provide information, explanations, and opinions on matters that otherwise would be beyond the understanding, common knowledge, and

⁶⁷ See Hon. William G. Young, *Vanishing Trials, Vanishing Juries, Vanishing Constitution*, 40 SUFFOLK U. L. REV. 67 (2006) (explaining how the jury trial is a uniquely American phenomenon and one deeply enshrined in our history, culture, and traditions). For a discussion of the evolution of the jury trial from colonial days to modern times and the ongoing debate over the jury's power to decide questions of law as well as fact see Albert W. Alschuler & Andrew G. Deiss, *A Brief History of the Criminal Jury in the United States*, 61 U. CHI. L. REV. 867 (1994).

⁶⁸ See, e.g., FED. R. CIV. P. 56 (permitting the court to grant summary judgment to a party and dispense with the jury trial guaranteed by the Seventh Amendment only if there is "no genuine dispute as to any material fact"); see *Dimick v. Schiedt*, 293 U.S. 474, 486 (1935) ("Maintenance of the jury as a fact-finding body is of such importance and occupies so firm a place in our history and jurisprudence that any seeming curtailment of the right to a jury trial should be scrutinized with the utmost care. The controlling distinction between the power of the court and that of the jury is that the former is the power to determine the law and the latter to determine the facts."); see generally Alschuler & Deiss, *supra* note 67, at 902–21 (discussing the long and controversial history of the allocation of authority between judge and jury on deciding questions of law).

experience of the jury. The jury considers the testimony of the percipient witnesses and the opinions of the experts, along with the other evidence in the case, to ultimately reconstruct the historical event in question so they can then apply the governing legal standards to reach a verdict in the case.

Of course, in the usual case, the percipient witnesses are not consistent. Their versions of the event vary, sometimes wildly. The experts are not consistent, either. Well-qualified, well-trained, well-spoken, and well-meaning scientists, doctors, accountants, engineers or other experts routinely reach diametrically opposed positions on the same issue. Just as with the inconsistencies among the percipient witnesses, the jury of laypersons is charged with reconciling the divergent scientific or technical testimony and deciding which is more believable.

Determining whom to believe, whom to trust, and whom to rely upon in reconstructing the historical incident is the sole and virtually sacred task of the American jury.⁶⁹ Indeed, juries are typically instructed by the presiding judge, “You are the sole

⁶⁹ See, e.g., *Aetna Life Ins. Co. v. Ward*, 140 U.S. 76, 88 (1891) (“There are many things sometimes in the conduct of a witness upon the stand, and sometimes in the mode in which his answers are drawn from him through the questioning of counsel, by which a jury are to be guided in determining the weight and credibility of his testimony. That part of every case, such as the one at bar, belongs to the jury, who are presumed to be fitted for it by their natural intelligence and their practical knowledge of men and the ways of men; and, so long as we have jury trials, they should not be disturbed in their possession of it, except in a case of manifest and extreme abuse of their function.”); see also *Kansas v. Ventris*, 556 U.S. 586, 594 (2009) (“Our legal system, however, is built on the premise that it is the province of the jury to weigh the credibility of competing witnesses”); *United States v. Scheffer*, 523 U.S. 303, 313 (1998) (“A fundamental premise of our criminal trial system is that ‘the jury is the lie detector.’”); *United States v. Bailey*, 444 U.S. 394, 414 (1980) (“The Anglo-Saxon tradition of criminal justice, embodied in the United States Constitution and in federal statutes, makes jurors the judges of the credibility of testimony offered by witnesses.”). For an historical account of the evolution of the jury as the courtroom’s lie detector see George Fisher, *The Jury’s Rise as Lie Detector*, 107 YALE L.J. 575, 580–83 (1997).

judges of the credibility or ‘believability’ of each witness and the weight to be given to the witness’s testimony.”⁷⁰

While the jury is the sole judge of the facts in a case, the rules of evidence control what information the jury is permitted to use in its reconstruction of the event giving rise to the litigation. The threshold for admissibility is, of course, relevance.⁷¹ Evidence that simply has no logical or legal connection to the case is not admissible.⁷² But the rules of evidence also exclude a great deal of otherwise relevant evidence.⁷³ Indeed, the body of law called evidence is a body of law that keeps facts from the trier of fact.⁷⁴

⁷⁰ PATTERN JURY INSTRUCTIONS (CRIMINAL CASES) § 1.08 (Comm. on Pattern Jury Instructions Dist. Judges Ass’n Fifth Circuit 2012); *see also* PATTERN CRIMINAL JURY INSTRUCTIONS § 1.07 (Sixth Circuit Comm. on Pattern Criminal Jury Instructions 2014); FEDERAL CIVIL JURY INSTRUCTIONS OF THE SEVENTH CIRCUIT § 1.13 (Comm. on Pattern Civil Jury Instructions of the Seventh Circuit 2009); MANUAL OF MODEL CRIMINAL JURY INSTRUCTIONS FOR THE DISTRICT COURTS OF THE EIGHTH CIRCUIT § 1.05 (Judicial Comm. on Model Jury Instructions for the Eighth Circuit 2014); CRIMINAL PATTERN JURY INSTRUCTIONS § 1.08 (Criminal Pattern Jury Instruction Comm. of the U.S. Court of Appeals for the Tenth Circuit 2011); ELEVENTH CIRCUIT PATTERN JURY INSTRUCTIONS (CRIMINAL CASES) § 5 (Comm. on Pattern Jury Instructions of the Judicial Council of the Eleventh Circuit 2010). For a typical state pattern jury instruction on credibility, *see* N.C. PATTERN JURY INSTRUCTIONS FOR CRIMINAL CASES § 101.15 (N.C. Conference of Superior Court Judges Comm. on Pattern Jury Instructions 2011).

⁷¹ FED. R. EVID. 401 (“Evidence is relevant if: (a) it has any tendency to make a fact more or less probable than it would be without the evidence; and (b) the fact is of consequence in determining the action.”).

⁷² FED. R. EVID. 402 (“Relevant evidence is admissible unless any of the following provides otherwise: the United States Constitution; a federal statute; these rules; or other rules prescribed by the Supreme Court. Irrelevant evidence is not admissible.”).

⁷³ *See, e.g.*, FED. R. EVID. (“The court may exclude relevant evidence if its probative value is substantially outweighed by a danger of one or more of the following: unfair prejudice, confusing the issues, misleading the jury, undue delay, wasting time, or needlessly presenting cumulative evidence.”).

⁷⁴ *See* Daubert v. Merrell Dow Pharm., 509 U.S. 579, 597 (1993) (recognizing that judges exercising their gatekeeping function under Rule 104(a) “inevitably on occasion will prevent the jury from learning of authentic insights and innovations. That, nevertheless, is the balance that is struck by Rules of

Some exclusionary rules seek to further policy goals unrelated to accurate fact-finding in the case under consideration.⁷⁵ Others seek to promote accurate fact finding by excluding unreliable information.⁷⁶ Still other rules deny the jury information out of a fear the jury may not be able to properly weigh the information in the context of the case under consideration.⁷⁷ Superintending the application of these rules is the trial judge who has tremendous discretion to admit or exclude evidence, control the mode and order of proof to promote accurate fact finding, avoid wasting time, and protect witnesses from harassment and undue embarrassment.⁷⁸

As we genuflect before the jury's mystical powers to distinguish between fact and fiction, social science research reports that human beings are really not very good at separating liars and truth-tellers.⁷⁹ The recent rash of publicized post-conviction relief cases where, typically, DNA evidence reexamined with new and

Evidence designed not for the exhaustive search for cosmic understanding but for the particularized resolution of legal disputes.”).

⁷⁵ See, e.g., FED. R. EVID. 407 (excluding evidence of subsequent remedial measures when offered to prove liability or culpable conduct); FED. R. EVID. 410 (excluding evidence of plea discussions under certain circumstances); FED. R. EVID. 501 (allowing privileges).

⁷⁶ See, e.g., FED. R. EVID. 702 (admitting only reliable expert opinion); FED. R. EVID. 802 (excluding hearsay).

⁷⁷ See, e.g., FED. R. EVID. 403 (excluding otherwise relevant evidence when the “probative value is substantially outweighed by a danger of . . . unfair prejudice, confusing the issues, misleading the jury, undue delay, wasting time, or needlessly presenting cumulative evidence”); FED. R. EVID. 404(a) (excluding most propensity evidence).

⁷⁸ FED. R. EVID. 104; FED. R. EVID. 611.

⁷⁹ See, e.g., Joseph W. Rand, *The Demeanor Gap: Race, Lie Detection, and the Jury*, 33 CONN. L. REV. 1, 3 (2000); Jeremy A. Blumenthal, *A Wipe of the Hands, A Lick of the Lips: The Validity of Demeanor Evidence in Assessing Witness Credibility*, 72 NEBR. L. REV. 1157, 1190–97 (1993); Olin Guy Wellborn III, *Demeanor*, 76 CORNELL L. REV. 1075, 1082–88 (1991). But see Max Minzner, *Detecting Lies Using Demeanor, Bias, and Context*, 29 CARDOZO L. REV. 2557, 2560 (2008) (observing that when bias and context are considered along with demeanor juries may be better at detecting lies than when relying upon demeanor alone, but suggesting more research is needed).

more accurate technology vindicates the defendant and thoroughly discredits eyewitness accounts have added to the skepticism about the jury's ability to accurately determine the historical facts.⁸⁰ When added to the claims of some neuroscientists that fMRI accuracy rates for lie detection exceed 90%, the rush to provide the jury with the opinion of the neuroscientist on whether a given witness is telling the truth or lying is understandable.⁸¹

Despite rather serious and obvious weaknesses in the technology, some have suggested that since the neuroscience-based opinion on credibility is better than what the jury brings to the task, the jury should at least have the benefit of the expert's opinion.⁸²

On the one hand, we tout our confidence in the jury's ability to make credibility judgments and accurately weigh the evidence, while on the other hand we question whether the jury can understand and appropriately weigh complex scientific evidence.⁸³ The fear is that lay juries may give excessive weight to colorful fMRI images showing a brain "processing a lie." This schizophrenic notion of the competence of juries as accurate fact-finders explains why the rules of evidence restrict what the jury hears and limits how it can

⁸⁰ The Innocence Project reports 311 post-conviction DNA exonerations in the United States since 1989. *DNA Exoneree Case Profiles*, INNOCENCE PROJECT, <http://www.innocenceproject.org/know/> (last visited Mar. 7, 2014). See, e.g., Mitch Weiss, *Judges Clear Two in 2000 Killing*, THE NEWS & OBSERVER (Sept. 23, 2011), <http://www.newsobserver.com/2011/09/23/1510069/judges-clear-two-in-2000-killing.html>.

⁸¹ See, e.g., Kozel et al., *supra* note 34, at 608–10 (reporting accuracy rates between 90% and 93%); Langleben, *supra* note 34, at 4 (citing various studies claiming accuracy rates above 90%); Simpson, *supra* note 31, at 491 (comparing reported accuracy rate of fMRI of 90% with much lower rates for polygraph); see also Testimony of Steven Laken, Transcript of Proceedings, May 13, 2010, Vol. 1 at 91, United States v. Semrau, No. 07CR10074-IJPM (W.D. Tenn.) (reporting 100% accuracy in detecting deception).

⁸² See Schauer, *supra* note 31, at 1210–19.

⁸³ See David L. Faigman, *Admissibility of Neuroscientific Expert Testimony*, in A PRIMER ON CRIMINAL LAW AND NEUROSCIENCE 89, 109 (Stephen J. Morse & Adina L. Roskies eds., 2013).

use what is admitted.⁸⁴ Ultimately, as imperfect as it is, the jury is the lie detector in the courtroom. The real question is whether our system should admit fMRI-based expert testimony on a witness's truthfulness to assist the jury in that task. The answer to this question involves consideration of the trial context in which the evidence is offered, the limitations imposed by evidence rules on expert opinion testimony, including the scientific validity of the underlying principles and methods, the balancing of the probative value of the testimony against the risk that it will confuse rather than enlighten the jury, and whether constitutional concerns should permit criminal defendants to offer such testimony even if the rules of evidence say otherwise.

IV. RULES OF EVIDENCE: ATTACKING AND SUPPORTING CREDIBILITY

Assuming that fMRI as a lie detector could satisfy the scientific reliability standards of Rule 702,⁸⁵ expert opinion testimony based on fMRI scanning that a witness is truthful or deceptive must meet the admissibility principles governing the impeachment and rehabilitation of testifying witnesses.⁸⁶ The trial itself is about the underlying historical facts that gave rise to the litigation, but the

⁸⁴ See, e.g., David P. McCabe & Alan D. Castel, *Seeing is Believing: The Effect of Brain Images on Judgments of Scientific Reasoning*, 107 COGNITION 343, 349–51 (2008) (finding scientific summaries more credible when accompanied by neuroimages); Deena Skolnick Weisberg et al., *The Seductive Allure of Neuroscience Explanations*, 20 J. COGNITIVE NEUROSCI. 470 (2008) (explaining that laypeople are dazzled by neurobabble); David P. McCabe et al., *The Influence of fMRI Lie Detection Evidence on Juror Decision Making*, 577 BEHAV. SCI. & L. 566, 572–75 (2011) (explaining that fMRI lie detection is more persuasive than other technologies in mock trial setting). But see Adina L. Roskies et al., *Neuroimages in Court: Less Biasing than Feared*, 17 TRENDS IN COGNITIVE SCI. 99, 101 (2013) (analyzing recent studies and finding no untoward impact of neuroscience images on juror decision making); Robert B. Michael et al., *On the (non)Persuasive Power of a Brain Image*, 20 PSYCHONOMIC BULLETIN REV. 720, 722–724 (2013) (finding brain images exerted little to no influence on whether people agree with conclusions in an article accompanying the image).

⁸⁵ See *infra* Sections V.A–V.C for a discussion of Rule 702 and fMRI.

⁸⁶ See generally FED. R. EVID. 601–615.

resolution of disputes surrounding those facts is often conditioned upon which witnesses the jury credits and which ones they discredit.

“Credibility” in the context of testimonial evidence is broader than whether a witness is consciously telling a lie. Witnesses can contradict one another on factual points without lying. One witness could be mistaken. Another could have had a better perspective or angle of vision. Still another might have forgotten a key point or become confused as to what she actually saw or heard. All of these situations can and do occur in trials every day, and juries routinely deal with them in weighing the evidence and judging the believability of witnesses. At this point in time, fMRI makes no claim to be able to determine which of these divergent factual accounts are more accurate. Thus, the admissibility of fMRI-based opinion on truthfulness only arises when the credibility issue is whether a witness deliberately and consciously lied during testimony at trial.⁸⁷

Important as the credibility issue may be, however, it is still one-off from the central issue at the trial, the reconstruction of the historical event that gave rise to the litigation. Recognizing the importance of credibility evidence, as well as its potential to distract the jury from the merits of the case, the Federal Rules of Evidence, and most state evidence rules, regulate the timing and the form of admissible evidence on the issue of witness credibility. To be admitted, an fMRI-based opinion on witness truthfulness has to clear more than the scientific reliability hurdle; it must also

⁸⁷ Defining a “lie” is not a simple matter, especially a “lie” that can be detected by fMRI scanning. See, e.g., Keckler, *supra* note 32, at 539 (explaining that deception is a “continuous rather than discrete variable”); Jed S. Rakoff, *Lie Detection in the Courts: The Vain Search for the Magic Bullet*, in USING IMAGING TO IDENTIFY DECEIT: SCIENTIFIC AND ETHICAL QUESTIONS 40, 44–45 (Emilio Bizzi et al. eds., 2009) (“The law recognizes many kinds of lies, ranging from ‘white lies’ and ‘puffing’ to affirmative misstatements, actionable half-truths, and material omissions.”). For a discussion of the difficulty in defining lies for fMRI lab studies and applying that definition to the real-world of trial testimony see *infra* notes 364–99 and accompanying text.

negotiate the labyrinth of rules that govern impeachment and rehabilitation of witnesses.

A. Timing: Impeach First, Rehabilitate Second

Evidence to bolster or support the credibility of a witness is generally not admissible until the witness has testified and the opponent has attacked his credibility.⁸⁸ Courts generally consider it a waste of time to admit evidence of a witness's good credibility until the opponent has attacked the witness's credibility through cross-examination and/or extrinsic impeachment.⁸⁹ Allowing anticipatory rehabilitation of a witness's credibility runs the risk of wasting time if no attack on credibility is forthcoming, injecting into the case credibility evidence that does not address facts subsequently introduced to attack credibility, and also risks distracting the jury from the underlying factual issues it must resolve.⁹⁰ Though the Federal Rules of Evidence explicitly adopted

⁸⁸ KENNETH S. BROWN, 1 MCCORMICK ON EVIDENCE § 33 at 60 (6th ed. 2006) ("Both at common law and under the Federal Rules, the general norm is that the witness's proponent may not bolster the witness's credibility before any attempted impeachment."); DAVID H. KAYE, ET AL., THE NEW WIGMORE: A TREATISE ON EVIDENCE: EXPERT EVIDENCE § 2.4 (2d ed. Supp. 2014) ("Testimony that merely attempts to bolster the credibility of another witness whose character for truthfulness has not been attacked normally is inadmissible."). See, e.g., FED. R. EVID. 608(a) ("The credibility of a witness may be attacked or supported by evidence in the form of opinion or reputation, but subject to these limitations: (1) the evidence may refer only to character for truthfulness or untruthfulness, and (2) evidence of truthful character is admissible only after the character of the witness for truthfulness has been attacked by opinion or reputation evidence or otherwise."); CHRISTOPHER B. MUELLER, LAIRD C. KIRKPATRICK AND CHARLES H. ROSE III, EVIDENCE: PRACTICE UNDER THE RULES § 6.18 at 488–89 (3d ed. 2009) ("At the outset it should be noted that generally a party may not *support* a witness who has not yet been attacked, which means especially that proof of good character may not be presented along with the initial testimony of a witness, and that prior *consistent* statements by the witness may not be offered along with his initial testimony.").

⁸⁹ Fresh complaints in sexual assault cases and statements of prior identification under FED. R. EVID. 801(d)(1)(C) are notable exceptions to this general rule. BROWN, *supra* note 88, at 84.

⁹⁰ *Id.*

this common law principle only with regard to evidence of a witness's good character for truthfulness,⁹¹ federal courts have continued to apply it to other forms of bolstering credibility, or "oath helping," through the balancing provisions of Rule 403 and the court's broad power to control the mode and order of proof under Rule 611(a).⁹² Application of this principle in the fMRI-based expert opinion on truthfulness context precludes admission of such evidence before the witness has testified at trial and been impeached.⁹³ Once this "timing rule" has been met, the admissibility of the positive fMRI opinion will depend upon whether the fMRI opinion refutes the form of the impeachment.⁹⁴

B. Form: Rehabilitation Must Meet the Impeachment

It is axiomatic that evidence to support credibility must respond to that offered to impeach credibility:

The [evidence supporting credibility] must meet the impeachment with relative directness. The wall, attacked at one point, may not be fortified

⁹¹ FED. R. EVID. 608(a).

⁹² See FED. R. EVID. 611(a) ("Control by the Court; Purposes. The court should exercise reasonable control over the mode and order of examining witnesses and presenting evidence so as to: (1) make those procedures effective for determining the truth; (2) avoid wasting time; and (3) protect witnesses from harassment or undue embarrassment."). *Id.* advisory committee's note ("Item (1) restates in broad terms the power and obligation of the judge as developed under common law principles. It covers such concerns as whether testimony shall be in the form of a free narrative or responses to specific questions, . . . the order of calling witnesses and presenting evidence, the use of demonstrative evidence, . . . and the many other questions arising during the course of a trial which can be solved only by the judge's common sense and fairness in view of the particular circumstances. Item (2) is addressed to avoidance of needless consumption of time, a matter of daily concern in the disposition of cases. A companion piece is found in the discretion vested in the judge to exclude evidence as a waste of time in Rule 403(b).")

⁹³ BROWN, *supra* note 88, at 84.

⁹⁴ It should also be noted that a hearsay declarant is subject to impeachment to the same extent as a live witness. FED. R. EVID. 806 ("When a hearsay statement—or a statement defined in Rule 801(d)(2)(C), (D), or (E)—has been admitted in evidence, the credibility of the declarant may be attacked, and if attacked may be supported, by any evidence which would be admissible for those purposes if the declarant had testified as a witness.").

at another, distinct point. Credibility is a side issue, and the circle of relevancy in this context should be drawn narrowly. When we reach the stage of rehabilitation after impeachment, we are rather far afield from the historical merits of the case; and the courts justifiably insist on a stronger showing of relevance to minimize the risk that the jury will lose sight of the merits. As a rule of thumb, the courts demand that the rehabilitation be a response in kind to the impeachment. Precisely how responsive is a question of degree as to which reasonable courts differ.⁹⁵

A simple hypothetical illustrates the point. If the witness is impeached by evidence tending to show that the noisy and smoke-filled bar impaired his ability to see and hear the fight between the defendant and the victim, evidence that the witness is a truthful person is irrelevant. In the language of Rule 401, his truthful disposition does not have any tendency to make his ability to see and hear in the conditions of the bar any better or more reliable.

C. *Application: Impeaching and Rehabilitating with fMRI*

To appreciate how fMRI-based expert opinion on truthfulness fits into this regulatory scheme, we must first consider the methods of impeachment and whether the impeachment employed was an attack on truthfulness. Assume that the witness has undergone fMRI scanning and the expert witness is prepared to testify that the scanning indicated the witness was being truthful when he answered the questions pertaining to the historical facts surrounding the issues at trial.⁹⁶ Also assume the witness's trial

⁹⁵ BROWN, *supra* note 88, at 84. The three cases in which fMRI-based expert opinion testimony on witness truthfulness has been offered all decided the admissibility issue in a pre-trial hearing and did not consider the limitations that the rules governing impeachment and rehabilitation would place on otherwise admissible expert opinion. *See supra* notes 8–30 and accompanying text.

⁹⁶ From a practical standpoint, using fMRI as a “truth verifier” is the more likely scenario. Litigants, both civil and criminal, are more likely to seek fMRI opinions to support their own veracity, or the veracity of percipient witnesses supportive of their theory of the case, than they are to seek a court order for an opposing party or other witness to undergo fMRI scanning. The fMRI studies thus far have all included willing volunteers and there is no data on whether the BOLD response would be the same for a witness who was compelled to undergo fMRI scanning. Furthermore, when the witness is the criminal defendant the

testimony was consistent with the answers he gave during that portion of the fMRI scan where he was instructed to answer the examiner's questions truthfully.⁹⁷ Understanding how the rules governing witness impeachment and rehabilitation influences the admissibility question raised by this straightforward hypothetical is important in appreciating the potential uses of fMRI-based expert opinion on witness truthfulness at trial.

Impeachment falls into one of five categories: (1) diminished capacity of the witness to observe, remember or relate the historical facts; (2) bad character for truth and veracity; (3) extrinsic evidence that contradicts the witness's version of events; (4) prior statements of the witness that are inconsistent with in-court testimony; and (5) the presence of bias that may induce the witness to slant or color his testimony in favor of the calling party.⁹⁸ To this commonly accepted list of impeachment methods, this Article would add another: (6) deliberate deception not inferred from one of the other impeachment modes. Due to fMRI's claim that it can detect lies directly, a direct attack on sincerity of the in-court testimony that does not depend upon an inference of deception from other modes of impeachment but is the product of deliberate deception irrespective of character, bias, inconsistency, or contradictory evidence is conceivable.

Constitution imposes significant hurdles to any compelled fMRI scanning. *See, e.g.,* Sean Kevin Thompson, *A Brave New World of Interrogation Jurisprudence*, 33 AM. J. L. & MED. 341 (2007) (addressing self-incrimination and due process issues). Assuming scientific reliability, and the opposing party was aware of the result of the tests, there would appear to be no specific impeachment limits, other than balancing probative value versus prejudicial effect, if the opposing party offers the expert's opinion to impeach after the witness testified. In this event, however, the likelihood of a trial is considerably diminished. In a jurisdiction that admits such evidence it is unlikely a party would proceed with the case if the key witness, or the party himself, has failed the lie detector. *See infra* notes 55–133 and accompanying text for a more detailed discussion.

⁹⁷ *See supra* notes 33–66 and accompanying text.

⁹⁸ CHRISTOPHER B. MUELLER AND LAIRD C. KIRKPATRICK, 3 FEDERAL EVIDENCE § 6.26 (3d ed. 2012).

1. *Capacity*

Impeachment by showing defects in capacity questions the witness's ability to perceive, understand, remember, or relate the facts of which the witness purports to have personal knowledge. In a marked departure from the common law, modern evidence codes eschew the long list of factors that disqualified witnesses from testifying and, instead, leave many of those considerations to the jury in weighing the evidence.⁹⁹

But being competent to testify is not the same as being an infallible repository of historical facts relevant to the case. Casting doubt on the reliability of a witness's testimony by showing defects in his capacity to observe, understand, recall, and relate the historical facts is regulated by the general principles of relevancy and the balancing of probative value against the danger of unfair prejudice, confusing the issues, misleading the jury, undue delay, wasting time, or needlessly presenting cumulative evidence.¹⁰⁰ No special rules limit the form of the evidence that may be offered to attack the witness's ability to perceive the matter about which the witness has testified.¹⁰¹ Accordingly, evidence of the witness's poor eyesight, obstructed vision, and other such matters are routinely presented to juries so that they may evaluate the accuracy and reliability of the witness's versions of the events.¹⁰²

However, impeachment by showing some degree of defect in the witness's capacity does not mean the witness is a liar or that the impeaching party is calling the witness a liar. For example, fMRI-based expert testimony that the witness was being truthful when asked about the events while in a scanner would not logically rebut evidence that the witness's line of sight was obscured by

⁹⁹ FED. R. EVID. 601 declares every person "competent to be a witness unless these rules provide otherwise."

¹⁰⁰ FED. R. EVID. 401, 402, 403, 611.

¹⁰¹ CHRISTOPHER B. MUELLER & LAIRD C. KIRKPATRICK, EVIDENCE § 6.21 (5th ed. 2012).

¹⁰² ROGER PARK, ET AL., THE NEW WIGMORE: A TREATISE ON EVIDENCE: IMPEACHMENT AND REHABILITATION § 8.1 (2nd ed. Supp. 2014) ("[T]he court will instruct the jury to draw its own conclusions about the faculties of a particular witness.").

trees or a road sign.¹⁰³ While the witness may sincerely believe she had a clear line of sight and unobstructed view of the scene and the resulting BOLD differential confirmed the sincerity of her belief, the issue is one of the accuracy of the witness's perception of the historical facts, not truth-telling. fMRI-based opinion testimony that the witness sincerely believed her version of the facts was accurate and that she was not being deceptive in describing what she saw, or thought she saw, does not address the underlying question of how well the witness could observe, understand, recall, and relate the historical facts. Because the fMRI opinion on truthfulness does not rebut the defect in capacity impeachment, it would not be admissible to rehabilitate the witness regardless of the reliability of the opinion.¹⁰⁴

2. *Character*

The rules of evidence have long disfavored evidence of a person's character or trait of character to prove conduct in conformity with that character trait.¹⁰⁵ With notable exceptions, the Federal Rules of Evidence codified the common law rule.¹⁰⁶ Rules

¹⁰³ By the same token, fMRI-based opinion testimony that the witness was deceptive during a scan is not an attack on capacity.

¹⁰⁴ See *supra* notes 90–95 and accompanying text.

¹⁰⁵ *Michelson v. United States*, 335 U.S. 469, 475–76 (1948) (“The inquiry is not rejected because character is irrelevant; on the contrary, it is said to weigh too much with the jury and to so overpersuade them as to prejudice one with a bad general record and deny him a fair opportunity to defend against a particular charge. The overriding policy of excluding such evidence, despite its admitted probative value, is the practical experience that its disallowance tends to prevent confusion of issues, unfair surprise and undue prejudice.”).

¹⁰⁶ FED. R. EVID. 404; FED. R. EVID. 405. At common law, a criminal defendant could prove his good character through witnesses who were familiar with his reputation in the community. The modern rule permits witnesses who have sufficient connection to and knowledge of the person whose character is being proved to testify as to their personal opinion of the character, as well as the person's reputation in the community. FED. R. EVID. 405(a). If the defendant attacks the character of the victim, the modern rule permits the prosecution to offer reputation or opinion evidence of that same character trait in the defendant. FED. R. EVID. 404(a)(2)(B)(ii). Additionally, the modern rules depart from the common law in generally protecting the character of a victim of sexual assault, FED. R. EVID. 412, and in permitting the prosecution and the plaintiff in a case of

404(a)(1) and (2), 405, and 412–415 regulate the admissibility of evidence of pertinent character traits and specific acts of misconduct of criminal defendants, the victims of crimes, and civil defendants in cases arising out of sexual assault or child molestation. Rule 404(a)(3) regulates admissibility of character evidence of a witness in either a civil or criminal case. It permits a party to offer character evidence of a witness only if the evidence complies with limits imposed by Federal Rules of Evidence 608 and 609.¹⁰⁷ Rules 608 and 609 permit impeachment by showing the witness has a bad character for truthfulness, but they also carefully regulate the form that the impeachment evidence can take.¹⁰⁸

Under Rule 608, a party can impeach Witness 1 by calling Witness 2 to attack Witness 1's "character for truthfulness."¹⁰⁹ This sort of impeachment, however, is quite constrained. Under Rule 608(a), extrinsic evidence of Witness 1's bad character for truthfulness is limited to his reputation for truthfulness within the community¹¹⁰ and/or Witness 2's opinion of his character for

sexual assault or child molestation to offer evidence in the case in chief of prior similar acts of the defendant to prove the defendants predisposition. FED. R. EVID. 413–415.

¹⁰⁷ "Exceptions for a Witness. Evidence of a witness's character may be admitted under Rules 607, 608, and 609." FED. R. EVID. 404(a)(3). Rule 607 permits any party to impeach any witness, including his own and does not impose any substantive limits on the mode of impeachment or the form the evidence may take.

¹⁰⁸ Rule 608, for example, excludes extrinsic evidence of prior conduct probative of truthfulness or untruthfulness. FED. R. EVID. 608(b). Rule 609 imposes limits on the type and age of prior convictions that are admissible to prove a witness's bad character for truthfulness. FED. R. EVID. 609.

¹⁰⁹ FED. R. EVID. 608(a) ("A witness's credibility may be attacked or supported by testimony about the witness's reputation for having a character for truthfulness or untruthfulness, or by testimony in the form of an opinion about that character.").

¹¹⁰ Reputation is, of course, what others say about the person whose character is in question. When offered for the truth of the matter asserted, *i.e.*, Bubba's reputation for truthfulness in the community is terrible, reputation is hearsay. Rule 803(21) provides the exception: "Reputation Concerning Character. A reputation among a person's associates or in the community concerning the person's character." FED. R. EVID. 803 (21).

truthfulness.¹¹¹ Admission of this sort of impeachment evidence allows the jury to infer that Witness 1 is generally not a truthful person and is probably acting consistently with that untruthful character trait and is not telling the truth at trial. Of course, the party who called Witness 1 can rebut this adverse character evidence by introducing opinion and reputation evidence from Witness 3 that Witness 1 is a generally truthful person.

Because the rules restrict the character witnesses to just their opinion of Witness 1's character for truthfulness and/or the reputation within the community of Witness 1 for truth and veracity, the jury never learns of the myriad of specific acts and incidents that formed the basis of the opinion or reputation. Furthermore, Rule 608(a) specifically conditions admission of evidence of good character for truth and veracity to situations where the opponent has first offered opinion or reputation evidence of bad character for truth and veracity.¹¹² In other words, absent an attack on Witness 1's character for truth and veracity, evidence to bolster the witness's credibility by introducing reputation and opinion testimony of good character for truth and veracity is specifically prohibited.

Additionally, Rule 608(b) prohibits extrinsic evidence of prior acts of the witness that either support or undermine his character

¹¹¹ In both instances, the character witness must have personal knowledge of the witness's reputation or a sufficient relationship with the witness to have an opinion as to the character trait of truthfulness. *United States v. Whitmore*, 359 F.3d 609, 616 (D.C. Cir. 2004); *United States v. Turning Bear*, 357 F.3d 730, 734 (8th Cir. 2004). See *infra* notes 287–311 and accompanying text for a discussion of whether expert opinion is admissible on the issue of witness truthfulness, generally. In the context of opinion under Rule 608, fMRI opinion is not admissible because fMRI-based opinion on truthfulness does not address “character for truthfulness or untruthfulness.” See DAVID L. FAIGMAN, ET.AL., MODERN SCIENTIFIC EVIDENCE: THE LAW AND SCIENCE OF EXPERT TESTIMONY § 40:8 (2012) (“Rule 608 thus does not obviously apply to the situation in which the witness states ‘X’ on the witness stand and the polygrapher testifies as to whether the witness was truthful in saying ‘X’ during the polygraph test.”).

¹¹² FED. R. EVID. 608(a).

for truth and veracity.¹¹³ The Rule's exclusion of extrinsic evidence of these acts forces the impeaching party to rely upon what the community thinks of the witness's character or to offer the personal opinion of one who knows the witness whose character is under attack without providing the jury the details of the basis of either the reputation or the opinion. The lack of specificity in this sort of impeachment makes its utility of questionable value and may discourage its use except in limited circumstances where the credibility of a witness is critical and the evidence of reputation and opinion is clear and consistent. Excluding specifics instances of conduct also avoids time-consuming and distracting mini-trials over the details of acts probative of character for truthfulness that accumulate over a person's lifetime. Permitting extrinsic evidence of this sort could easily bog the trial down in collateral matters far removed from the historical events giving rise to the litigation.¹¹⁴

Similarly, Rule 609 permits the use of certain prior convictions as evidence of a witness's bad character for truthfulness.¹¹⁵ At common law, felons were deemed not competent to testify at trial.¹¹⁶ The underlying felony conviction was evidence of a disregard of or failure to comply with the law and was evidence that the felon would not comply with the oath to testify truthfully.¹¹⁷ Modern rules removed the disqualification and admit

¹¹³ "Specific Instances of Conduct. Except for a criminal conviction under Rule 609, extrinsic evidence is not admissible to prove specific instances of a witness's conduct in order to attack or support the witness's character for truthfulness. But the court may, on cross-examination, allow them to be inquired into if they are probative of the character for truthfulness or untruthfulness of: (1) the witness; or (2) another witness whose character the witness being cross-examined has testified about." FED. R. EVID. 608(b); *see also* FAIGMAN, ET AL., MODERN SCIENTIFIC EVIDENCE: THE LAW AND SCIENCE OF EXPERT TESTIMONY § 40:8 (2012) ("But subsection (b) [of Rule 608] specifically provides that 'specific instances of conduct' *cannot* be introduced to support or attack credibility.") (emphasis added).

¹¹⁴ *See* BROWN, *supra* note 88, at 73.

¹¹⁵ FED. R. EVID. 609.

¹¹⁶ BROWN, *supra* note 88, at 74.

¹¹⁷ *See id.*

certain prior convictions as evidence of the witness's bad character for truth and veracity.¹¹⁸

If, for example, the defendant testified on direct examination that he did not rob the convenience store and the prosecution brought out on cross examination or offered extrinsic evidence that the defendant was convicted of filing a false income tax return five years earlier, the defendant's character for truthfulness would have been attacked.¹¹⁹ The fact of the conviction for filing a false income tax return is evidence from which the jury may infer the defendant has an untruthful character and that his in-court testimony in the current trial may be consistent with that untruthful character. In other words, the bad character for truthfulness impeachment through a prior conviction allows the jury to conclude, "He lied on his income tax return five years ago so he's probably lying today."

In responding to impeachment for bad character for truthfulness, Rule 608(a) specifically limits the rehabilitation evidence to opinion and reputation testimony about the witness's good character for truthfulness.¹²⁰ Opinion testimony by the fMRI expert, however, that on a specific day at a specific place and in response to specific questions the defendant was telling the truth is not an opinion as to the defendant's character for truthfulness. Rather, it asks the jury to believe the witness today because, in the opinion of the expert, he told the truth about the incident on a past occasion. In this regard, the testimony is more akin to extrinsic evidence of specific acts of truthfulness, something the Rules forbid.¹²¹

The fMRI expert, assuming he has sufficient knowledge and familiarity with the defendant so that he can form an opinion as the

¹¹⁸ FED. R. EVID. 609.

¹¹⁹ See FED. R. EVID. 609(a)(2).

¹²⁰ FED. R. EVID. 608(a). For example, in response to an impeachment by bad reputation for truthfulness or by a prior conviction admissible under Rule 609, rehabilitation is limited to opinion or reputation evidence of good character for truthfulness.

¹²¹ FED. R. EVID. 608(b) ("Except for a criminal conviction under Rule 609, extrinsic evidence is not admissible to prove specific instances of a witness's conduct in order to attack or support the witness's character for truthfulness.").

defendant's character for truthfulness, can only testify on direct examination that, in his opinion, the defendant is a generally truthful person. He cannot, on direct examination and in response to an attack on the witness's character for truthfulness, go into the underlying events, interactions, or specific events that allowed him to reach the opinion that defendant is a person who has a truthful character.¹²² In reality, an fMRI expert hired to conduct an fMRI scan while questioning the defendant about the details of the charged offense is hardly going to possess the sort of relationship with the defendant that courts require in order to testify to general character for truthfulness.¹²³ It is similarly unlikely that the retained expert would be sufficiently familiar with the community in which the defendant lives and works to testify to the defendant's reputation for truth and veracity within that community.

No proponent of fMRI as a truth verifier or lie detector has claimed that fMRI can reveal a person's general character for truthfulness. To date, the claim has only been that the fMRI scan can reveal deception and verify truth solely when the person is undergoing the scan and being questioned about a past event.¹²⁴

Taken as a whole, the impeachment and rehabilitation rules concerning a witness's character for truthfulness only admit opinion and reputation evidence of the witness's character trait of

¹²² FED. R. EVID. 608.

¹²³ Rule 608 does not specify the extent, length, or nature of the relationship between the character witness and the witness whose character is in question. Courts do, however, require a showing that the character witness has had sufficient contact and relationship with the principal witness to enable the character witness to form an opinion for truthfulness. *See, e.g.,* *United States v. Turning Bear*, 357 F.3d 730, 733–34 (8th Cir. 2004) (finding daily contact with child for four to six months sufficient to permit foster parent to give an opinion as to child's character for truth and veracity).

¹²⁴ In *Semrau*, Dr. Laken “emphasized that he was not offering an opinion about what Dr. Semrau's mental state was at the time that he allegedly committed the crime or whether Dr. Semrau possessed the requisite *mens rea*, [or whether Dr. Semrau was a generally truthful person]. Instead, Dr. Laken stated that he could only testify that, in his opinion, Dr. Semrau answered the questions during the fMRI scan truthfully ‘overall.’” *United States v. Semrau*, No. 07–10074, 2010 WL 6845092, at *7 n.15 (W.D. Tenn. June 1, 2010).

truthfulness. The only extrinsic evidence of bad character for truthfulness the rules permit, is certain prior criminal convictions.¹²⁵ The only way the specifics of an fMRI scan could even be mentioned is if (1) the retained expert had sufficient personal knowledge of the defendant to form the opinion that he was a truthful person generally; (2) the cross-examiner inquired into the basis of that opinion; and (3) the expert then revealed the fMRI scan and the results that supported his opinion.

These limitations on the type of evidence admissible to impeach or rehabilitate a witness reflect the general policy goal of keeping the jury focused on the conduct of the accused on the day in question and avoiding mini-trials over the credibility of a witness. Because an fMRI-based opinion on truthfulness is not a statement about the witness's character for truth and veracity within the meaning of Rule 608(a), it is not admissible either to impeach a witness for bad character for truthfulness or to rehabilitate the witness after a character impeachment. The Rule 608(b) prohibition on extrinsic evidence of specific acts probative of character of truthfulness excludes the expert testimony about the fMRI scan itself and the expert's interpretation of it.¹²⁶

3. *Contradiction*

Impeachment by contradiction occurs any time a party introduces any substantive evidence that contradicts or is inconsistent with the testimony of any other witness in the trial. It happens in every contested trial. The plaintiff, for example, may testify that he had the green light when he entered the intersection. During the defense case-in-chief the defendant may testify that she had the green light at the time of the accident. When defendant testifies that she had the green light, she has not only offered

¹²⁵ See FED. R. EVID. 609.

¹²⁶ For a consideration of confronting the witness on cross-examination with the results of an fMRI scan, see *infra* notes 141–49 and accompanying text.

substantive evidence of the color of the light, but has also impeached the plaintiff by contradicting his version of events.¹²⁷

Impeachment by contradiction, however, does not necessarily mean the impeached witness consciously lied on the witness stand. The difference between the contradictory versions of events may be one of simple mistake, different perspective, or memory failure. The primary witness may even be correct from an historical perspective and the contradicting witness is relaying the faulty version. The jury must evaluate the competing versions in light of other evidence in the case and decide which is the most reliable and what credit to give the testimony of the various witnesses. Both witnesses could be sincerely “telling the truth,” yet still vary significantly in their recollection of the facts. Accordingly, merely offering evidence that contradicts an opponent’s witness on the historical facts does not open the door for the opponent to “rehabilitate” his witness by offering evidence of good character for truthfulness.¹²⁸ To hold otherwise would bring a parade of good character witnesses into the court only to be followed by a number of bad character witnesses. The historical events giving rise to the litigation could quickly become lost in the clutter if the trial became centered on the character for truthfulness of the contradicted witness. Rehabilitation by offering evidence of good character for truthfulness would only be appropriate if the contradiction was connected to a direct attack on the witness’s veracity.¹²⁹

By the same token, only if the impeachment by contradiction carried a specific attack on the veracity of the impeached witness’s trial testimony would an expert opinion on truthfulness be

¹²⁷ The common law regulated this method of impeachment by excluding extrinsic evidence offered solely to impeach a witness on a collateral matter. 1 MICHAEL H. GRAHAM, MODERN STATE AND FEDERAL EVIDENCE: A COMPREHENSIVE REFERENCE TEXT 573 (1989). While this principle was not specifically codified in the Federal Rules, courts reach the same result through the application of Rules 401, 402, 403 and 611. MUELLER, ET. AL., *supra* note 88, § 6.43, at 558.

¹²⁸ BROUN, *supra* note 88, at 84.

¹²⁹ *Id.*

remotely relevant to rehabilitate the impeached witness. In the routine situation where impeachment by contradiction with extrinsic evidence is permitted, it is difficult to see how eliminating all other possible explanations for the difference in the testimony and leaving only a conscious and deliberate lie as the reason for the difference could be presented. Whether the reason for the difference in testimony was due to mistake, failed memory, poor perception, or an outright lie, the actual impeaching evidence is the contradictory testimony of another witness or some other proof of the contested fact. In other words, impeachment by contradiction tells the jury the witness “got it wrong,” not that the witness lied about it. Thus, offering fMRI-based opinion to rehabilitate the impeached witness would not resolve the question of whether a witness “got it wrong.” It would only tell the jury that the impeached witness believed her own story and does not meet the impeachment at the point of attack. Supporting evidence to rehabilitate the impeached witness would need to independently confirm the facts as she related them. fMRI proponents do not claim that fMRI can do that.¹³⁰

4. *Inconsistency*

Inconsistency, or self-contradiction, occurs when the same witness tells different versions of the story on different occasions. Bystander, an eyewitness to the robbery of a convenience store may tell the police the perpetrator drove away in a dark blue four-door sedan. At trial, Bystander may testify under oath that the perpetrator escaped on foot. The inconsistency between the two versions creates doubt as to Bystander’s reliability as a witness. It

¹³⁰ Some researchers have explored whether the brain responds differently to familiar objects than to unfamiliar ones, thus raising the question whether fMRI can expose “hidden knowledge.” Even less research has gone into this use of fMRI than has been devoted to identifying the neural correlates of deception. See, e.g., Matthias Gamer, et al., *fMRI-Activation Patterns in the Detection of Concealed Information Rely on Memory Related Effects*, SOC. COGNITIVE & AFFECTIVE NEUROSCIENCE, 506, 506 (2012) (reporting on results of “guilty knowledge test” using fMRI but advising against any forensic application); Greely, *supra* note 3, at 127–30 (concluding fMRI and EEG-based tests to expose hidden memory needs more research).

does not mean, however, that he was telling a lie from the witness stand at trial. Maybe he was mistaken. Maybe his memory failed. Maybe he thought long and hard about what he had seen and he remembered things differently after that exercise. Any number of explanations other than consciously lying could account for the inconsistency, all of which are properly considered by the jury in deciding the weight to give his testimony at trial, but none of which are discernible by fMRI.

Like contradiction, inconsistency generally does not implicate the witness's character for truthfulness nor does it necessarily suggest the witness lied in court. It means the witness told different stories on different days and he is, at best, an unreliable source of historical information. fMRI-based opinion that the witness was truthful in the scanner would be relevant to rehabilitate the witness only if the in-court testimony can be classified as a lie.¹³¹

5. *Bias*

The fifth method of impeachment is evidence of a witness's bias. Regulated only by the general rules of relevance and concerns of unfair prejudice, confusion, and waste of time, evidence that a witness favors a party, has antipathy toward a party, or has some self-interest in the matter that may color her testimony is generally admissible.¹³² The facts tending to show bias may be elicited on cross-examination of the witness or proved with extrinsic evidence.¹³³ From the facts establishing bias, the jury can infer the witness is likely to slant her testimony in a certain direction.

~~Bias does not necessarily~~ imply the witness is telling a deliberate lie, however. Parties to a case routinely testify to their version of the facts and they, of course, have an interest in the outcome of the case. It does not follow that both the plaintiff and

¹³¹ Inconsistency can, however, support a charge of deliberate deception. See *United States v. Scheffer*, 44 M.J. 442, 444 (C.A.A.F. Cir., 1996) (after testifying in his own behalf, Airman Scheffer was impeached with a prior inconsistent statement and on closing the prosecutor argued, "He lies. He is a liar. He lies at every opportunity he gets and he has no credibility.").

¹³² *United States v. Abel*, 469 U.S. 45 (1984).

¹³³ MUELLER & KIRKPATRICK, *supra* note 98, § 6.76, at 507.

the defendant in a case are telling deliberate lies from the witness stand because of their interests in the outcome. The same can be said of those who have some favorable or unfavorable relationship with a party. The nature and extent of the relationship may indicate a bias for or against a party and the resulting testimony may be delivered through such a filter. But the existence of the filter is not necessarily evidence of a deliberate lie.

Additionally, bias may be unconscious: witnesses may be biased and not realize it. Their perception of the events at issue, their understanding of the situation, and their recounting of the experience may all be influenced by an unconscious bias. It does not mean, however, that they are deliberately lying.¹³⁴

Rehabilitating a witness after a bias impeachment generally involves introducing evidence to counter the existence of the bias itself, minimize its influence on the witness, or show the witness testified truthfully despite the bias. Like evidence of bias itself, evidence to refute bias is regulated only by Federal Rules of Evidence 401, 402, 403, and 611. If a particular bias impeachment expressly or impliedly charges that the bias motivated the witness to deliberately falsify her testimony, the fMRI-based expert opinion that the witness was truthful when recounting the same story in the scanner would be relevant to rehabilitate the witness. The fMRI-based opinion would be evidence that the witness testified truthfully and her testimony was not a product of her bias.

¹³⁴ Neuroscientists have begun to investigate whether fMRI can reveal the existence of unconscious bias. By comparing the results of a standard racial bias testing instrument, the Implicit Association Test (IAT), with fMRI results while subjects viewed photos of unknown men of the same and different race, at least one researcher has observed higher activation in the amygdala, the part of the brain associated with emotions, and a correlation with higher scores of racial bias on the IAT. Greely, *supra* note 3, at 132–33. The research into this area is too premature to make any useful predictions. Suffice it say, however, that if neuroscience could reliably identify hidden biases that influence how we think, act, decide, and interact, the issue may become whether judges and jurors, as well as witnesses, should undergo fMRI before participating in a trial. The implications for our justice system would be staggering. They are also beyond the scope of this article.

6. *Deliberate Deception*

As illustrated by the foregoing discussion of the typical means of impeachment and rehabilitation, fMRI-based opinion that the witness was truthful during the scan is not admissible to bolster credibility before impeachment. Nor is the evidence that the witness was truthful during the scan admissible to rehabilitate the witness in most impeachment scenarios. There are times, however, when the impeachment does rise to the level of either expressly or impliedly attacking the witness's trial testimony as a deliberate lie. In those situations, fMRI may be relevant to rebut the impeachment.¹³⁵ To isolate the unique situations that would most likely trigger the admission of fMRI-based opinion testimony on truthfulness and to avoid the impression that fMRI evidence is only admissible if a particular mode of impeachment is employed, this Article has added the category of Deliberate Deception to the commonly recognized modes of impeachment.¹³⁶

Branding a witness a liar, whether a party, non-party percipient witness, or an expert witness, is a serious matter. Trial judges have the responsibility to control the mode and order of proof to "protect witnesses from harassment or undue embarrassment."¹³⁷ Most courts forbid questions on either cross-examination or direct-examination asking a witness to characterize the testimony of another witness as a "lie."¹³⁸ Similarly, courts take a dim view of lawyers using the "L" word during cross-examination or closing argument unless the evidence admitted at trial clearly supports that

¹³⁵ Rule 801(d)(1)(B) recognizes impeachment may raise "an express or implied charge that the declarant recently fabricated . . . [the in-court testimony] or acted from a recent improper influence or motive in so testifying." FED. R. EVID. 801(d)(1)(B).

¹³⁶ See *infra* notes 138–65 and accompanying text for a discussion of how fMRI could be used to impeach a witness with evidence of deliberate deception.

¹³⁷ FED. R. EVID. 611(a)(3).

¹³⁸ 4 MICHAEL H. GRAHAM, HANDBOOK OF FEDERAL EVIDENCE § 611:18 (7th ed. 2012) (collecting cases).

conclusion.¹³⁹ Calling a witness a liar is tantamount to alleging the witness committed perjury as he testified before the jury.

a. *Intrinsic Impeachment: Cross-Examining the Witness*

First, consider impeachment that levels a charge of deliberate deception. A typical scenario might be that a government subjected the “star” witness in a criminal case to fMRI scanning and the expert determined the witness was being deceptive when he implicated the defendant in the crime charged.¹⁴⁰ The prosecutor disclosed the result of the fMRI examination to the defense, but still called the witness in the government’s case in chief.¹⁴¹ The witness’s testimony implicated the defendant in the crime charged. Can the defense counsel cross-examine the witness about the results of the fMRI scan, or call the expert in rebuttal to give his opinion that the witness was lying when during the scan he implicated the defendant in the charged offense?

The impeachment on cross-examination would, necessarily, take the form of asking whether the witness failed the fMRI test. Of course, the witness has no way of knowing whether he “failed” the test unless he was so informed by either the person conducting the test or the prosecutors who arranged for the test. Accordingly,

¹³⁹ The facts of the case and the nature of the evidence determine where the line is between proper and improper questioning and argument. *Compare* United States v. Iacona, 728 F.3d 694, 701 (7th Cir. 2013) (ruling no error for prosecutor to repeatedly refer to Defendant as liar; evidence at trial made such a charge fair argument), *with* United States v. Woods, 710 F.3d 195, 208 (4th Cir. 2013) (ruling plain error, but not reversible error, for prosecutor to refer to Defendant as liar during closing argument). For an entertaining look at the considerations, and pitfalls, associated with using the “L” word, *see* James W. McElhaney, *LIAR! Dealing with Dishonesty in the Courtroom*, 80 A.B.A. J. 74 (1994).

¹⁴⁰ For the sake of discussion, assume the witness voluntarily agreed to undergo the scan and cooperated fully with the fMRI expert.

¹⁴¹ In *Giglio v. United States*, 405 U.S. 150, 154 (1972), the Court held that impeachment evidence was subject to the disclosure requirements of *Brady v. Maryland*, 373 U.S. 83 (1963). *But see* Wood v. Bartholomew, 516 U.S. 1, 5 (1995) (finding failure to disclose polygraph results to defense not a *Brady* violation because test results were not “material” and would not have affected the outcome of the trial).

the witness lacks personal knowledge of the outcome of the test as required by Federal Rule of Evidence 602.¹⁴²

If the question seeks to elicit what the witness was told about the test results, it would be hearsay if offered to prove that the witness did, in fact, fail the fMRI test.¹⁴³ If, however, the witness learned of the results from the prosecutor, or if the examiner was an agent or employee of the government, the answer could be the statement of a party opponent and the hearsay rule would not bar admission.¹⁴⁴ If the statement of the examiner, prosecutor, or other agent of the government informing the witness of the test results meets the Federal Rule of Evidence 801(d)(2) exemption from the definition of hearsay, the personal knowledge requirement of Rule 602 no longer applies,¹⁴⁵ clearing the way for admission of the

¹⁴² “A witness may testify to a matter only if evidence is introduced sufficient to support a finding that the witness has personal knowledge of the matter. Evidence to prove personal knowledge may consist of the witness’s own testimony. This rule does not apply to a witness’s expert testimony under Rule 703.” FED. R. EVID. 602.

¹⁴³ FED. R. EVID. 801(a)–(c). The question would be eliciting the out of court statement of the fMRI expert, “The fMRI scan shows you are lying,” to prove that fact.

¹⁴⁴ Rule 801(d)(2) exempts from the hearsay definition statements made by various individuals associated with an opposing party. When these statements are offered against the party whose agent or employee made or adopted the statement, the statement is not hearsay. Some Circuits have applied Rule 801(d)(2) to statements made by agents of the government. *See, e.g.*, *United States v. Kattar*, 840 F.2d 118, 131 (1st Cir. 1988); *United States v. Morgan*, 581 F.2d 933, 937 n.10 (D.C. Cir. 1978); *Bellamy v. State*, 941 A.2d 1107, 1115–16 (Md. 2008) (collecting federal cases). Others have held that no individual could bind the sovereign by a statement and that Rule 801(d)(2) does not apply to statements by agents of the government. *See, e.g.*, *United States v. Powers*, 467 F.2d 1089, 1095 (7th Cir. 1972); MUELLER ET AL, *supra* note 88, at 910 (“[B]etter . . . [reasoned cases] indicate that the admissions doctrine may be invoked against the government.”).

¹⁴⁵ The exclusion of statements of party opponents from the definition of hearsay is a function of the adversary system and is not based upon notions of reliability and trustworthiness like the categorical exceptions. FED. R. EVID. 801(d)(2) (“No guarantee of trustworthiness is required in the case of . . . [statements of party opponents]. The freedom which . . . [statements of party opponents] have enjoyed from technical demands of searching for an assurance

results of the fMRI on cross-examination of the witness who underwent the procedure.

If the defendant's counsel cannot fit the statement of the results into Rule 801(d)(2)'s hearsay exemption, she might attempt to avoid the personal knowledge and hearsay barriers by offering the evidence for the non-hearsay purpose of showing effect on the listener (the witness) or the current state of mind of the witness. The problem with this approach is that learning he failed the fMRI test does not make it more likely that the story he told in the scanner and at trial is the product of deliberate deception. The question is still whether he told the truth at trial and the fact that he learned that the fMRI examiner thought he was lying does not make it more likely that the story he told was an *actual* lie. Thus, if the fMRI results are not offered for the truth of the matter asserted they are irrelevant to prove that the in-court testimony was a lie.

One might argue that Rule 608(b) permits cross-examination of witnesses about specific instances of conduct that are probative of character for truthfulness and asking about the failed fMRI is merely applying the plain language of the rule. There are three problems with that argument. First, Rule 608 is concerned with *character* for truthfulness. In the impeachment setting, the prior acts must be probative of *bad character* for truthfulness. While voluntarily submitting to an fMRI exam may be probative of the witness's subjective belief in the truthfulness of his story and one might be able to infer from that subjective belief that the witness's character for truthfulness is good, the evidence here is being offered to prove the witness lied, not that he told the truth. The fact that he underwent fMRI scanning is not probative of his *bad character* for truthfulness.

Second, the specific act of lying while in the scanner is probative of *bad character* for truthfulness only if we know and accept that the result of the examination concluded he was being

of trustworthiness in some against-interest circumstances, and from the restrictive influence of the opinion rule and the rule requiring firsthand knowledge, when taken with the apparently prevalent satisfaction with the results, calls for generous treatment of this avenue to admissibility.”).

deceptive while in the scanner. But any probative value into the truthfulness of the witness in these circumstances depends on the accuracy of the exam. As explained above, the fMRI-based opinion of the expert is not admissible through cross-examining the witness in order to impeach unless it fits within the Rule 801(d)(2)(A)–(D) exemption for the hearsay rule.¹⁴⁶ Further complicating the problem is that the typical fMRI lie detection examination will consist of at least two scans covering the same topic. On one scan the subject is asked to respond truthfully and on the other is asked to respond deceptively.¹⁴⁷ The comparison of the two scans allows the examiner to see whether the BOLD response during the “truth” scan is equal to or greater than the BOLD response observed during the “lie” scan.¹⁴⁸ If it is, deception is indicated. If not, the subject is thought to be telling the truth. Accordingly, all fMRI examinations require the subject to “lie” at some point during the scan.¹⁴⁹ Conducting a cross-examination that suggests the “lie” during the scan is an act probative of character for truthfulness is, therefore, misleading and could lead to considerable confusion since the examination itself requires the subject to lie in order to capture the relative BOLD response between the brain state of “lying” and the brain state of “truth telling.”

The third problem is that if the witness was asked whether he “failed” the fMRI and answered by either denying he underwent scanning or that he passed the test instead of failing it, the impeaching party would be stuck with that answer. Rule 608(b) permits cross-examination on prior instances of conduct probative of bad character for truthfulness. Lying while undergoing an fMRI exam may well be probative of bad character for truthfulness. But Rule 608(b) specifically precludes proving the prior act by extrinsic evidence and, accordingly, prevents calling the fMRI expert. Reliance upon Rule 608(b) as authority to cross-examine a

¹⁴⁶ *Supra* notes 141–43 and accompanying text.

¹⁴⁷ *See supra* notes 46–52 and accompanying text.

¹⁴⁸ *Id.*

¹⁴⁹ *Id.*

witness about an fMRI scan creates a conundrum if the cross-examiner does not like the answer and then tries to prove the specific act by calling the fMRI examiner.

b. *Extrinsic Impeachment: Calling the fMRI Expert*

To expand upon the current hypothetical, assume the cross-examiner did not ask the witness about the fMRI test during cross-examination but, instead, called the fMRI examiner as an expert and offered the opinion of the expert to directly impeach the witness's in-court testimony. This form of impeachment does not implicate any of the five traditional methods of impeachment. It does not go to the witness's capacity to observe, understand, remember, or relate. It does not seek to establish the witness's bad character for truthfulness from which the jury can infer testimony at trial consistent with that bad character. If the scanner test itself is a prior statement, it is a consistent one. It does not offer a prior inconsistent statement; in fact, it does not impeach by offering contradictory facts that go to the merits of the case. And, it does not suggest some bias on the part of the witness that may have influenced his testimony. Rather, the offered evidence is scientific proof that the facts related by the witness are the result of conscious and deliberate deception.

There is nothing in the Federal Rules of Evidence that says only the five traditional methods of impeachment are permissible. Rule 607 allows any party to impeach any witness; "impeach" is not further defined by the rules.¹⁵⁰ In this setting, the rules and practices that regulate our traditional methods of impeachment are not dispositive, and the admissibility is determined solely by Rules 401, 402, 611 702–705 and 403.¹⁵¹ The expert opinion has some tendency to make it more likely that the in-court testimony was false.¹⁵² Rule 402 admits relevant evidence unless it is excluded by

¹⁵⁰ FED. R. EVID. 607.

¹⁵¹ For this discussion assume that Rules 702–705 governing expert testimony have been satisfied. For a discussion of the application of Rules 702–705 to fMRI-based expert opinion on witness truthfulness, see *infra* Parts V.A–V.C.

¹⁵² FED. R. EVID. 401.

some other rule, statute, or provision of the Constitution.¹⁵³ Rule 403 is a rule that excludes otherwise relevant evidence if the probative value of the proposition for which it is offered is substantially outweighed by the danger of unfair prejudice, confusion of the issues, misleading the jury, or causing undue delay, waste of time, or the needless presentation of cumulative evidence.¹⁵⁴ This balancing test is tilted decidedly toward admission, but the court has tremendous discretion in balancing the relevant factors.¹⁵⁵ Thus, the only limits on this sort of testimony to impeach a testifying witness are those governing expert testimony, the balancing provisions of Rule 403, and the court's power to control the mode and order of proof under Rule 611.

While this frees the proponent from the labyrinth of textual rules and the unwritten common law rules that still influence judges, it does not necessarily mean that the door is wide open to fMRI-based opinion testimony on witness truthfulness. The testimony must, of course, clear the significant hurdle of Rule 702. Then the court must find that countervailing considerations under Rule 403 do not substantially outweigh the probative value of the evidence. Perhaps the biggest obstacle here is the practical one: the party calling the witness must have (1) subjected the witness to an fMRI exam; (2) the result of the fMRI exam must have indicated deliberate deception; (3) the exam and the results must have been disclosed to the opposing party; (4) in spite of the failed exam and the availability of the fMRI evidence to impeach, the proponent must have called the witness at trial; and (5) the witness must have testified at trial consistent with the story he told during the "truth" portion of the fMRI scan.¹⁵⁶ Aligning all of the legal and practical stars to pave the way for admission of fMRI-based expert opinion to impeach a witness with extrinsic expert opinion that the witness failed the fMRI scan is a daunting task, is in large measure

¹⁵³ FED. R. EVID. 402.

¹⁵⁴ FED. R. EVID. 403.

¹⁵⁵ See *infra* Part VI. Rules of Evidence: Balancing Probative Value Versus Prejudicial Effect.

¹⁵⁶ See *supra* notes 135–55 and accompanying text.

controlled by the trial decisions and tactics of the opposing party, and will be the rare exception, not the routine.

c. *Extrinsic Rehabilitation: Calling the fMRI Expert to Support Truthfulness*

From the foregoing, it is apparent that if the party calling the witness subjected the witness to an fMRI examination that indicated deception and was obligated to disclose that fact to the opposing party, the door to admission of the expert's opinion is opened, however slightly, if the witness testifies at trial. But what if the fMRI scan determined the witness was truthful? Assuming the rules governing expert testimony are satisfied, is the fMRI-based opinion that the witness was truthful admissible to rehabilitate the credibility of the witness?

As the prior discussion of impeachment and rehabilitation explained,¹⁵⁷ the question of supporting a witness with fMRI-based opinion on truthfulness only arises after the witness has testified, or the hearsay declarant's statement has been admitted as an exception to the hearsay rule, and the witness has been impeached by means or methods that expressly or impliedly charge the witness with lying at trial.

As has been shown, not all impeachment carries with it the charge of deliberate deception. The most likely impeachment scenarios that carry the charge of lying¹⁵⁸ are: (1) vigorous cross-

¹⁵⁷ See *supra* notes 55–133 and accompanying text.

¹⁵⁸ Interestingly, the form of impeachment that always infers the witness is lying in court is an attack on character for truthfulness in the form permitted by Rule 608 or Rule 609. The theory behind the impeachment is that the witness has the general propensity to lie and is acting consistent with that propensity while testifying at trial. The form the evidence must take to accomplish the impeachment is highly regulated, as is the evidence admissible to rehabilitate. Insofar as the fMRI examination of the witness is a specific act probative of truthfulness, Rule 608(b) does not admit extrinsic evidence of such acts to rebut the inference of in-court deception created by the impeachment. Because the fMRI-based opinion would necessarily come from the expert who conducted the scan, the bar on extrinsic evidence excludes it. Furthermore, expert opinion based on fMRI scanning is not an opinion of the witness's character for

examination that expressly or impliedly attacks the veracity of the witness's testimony; (2) introduction of contradicting facts that, if true, expose the witness's contrary version as the product of deliberate deception as opposed to a difference in perception or perspective; (3) inconsistencies between the in-court testimony and prior statements that could only be explained by conscious deception at trial; and (4) bias or corruption so profound that the most likely conclusion is that the witness lied.¹⁵⁹

Whether the impeachment actually charges in-court fabrication so the fMRI-based opinion of truthfulness becomes relevant to rebut the charge is a matter trusted to the discretion of the trial judge. If the trial judge does not believe the impeachment included an express or implied charge of deliberate deception, the proffer of fMRI-based testimony of witness truthfulness would not meet the impeachment at the point of attack and would be irrelevant.¹⁶⁰

Because the admissibility of fMRI-based expert opinion on witness truthfulness will turn upon the manner in which a witness was impeached, control over the admissibility of the opinion lies, to some degree, within the power of the opponent. As a matter of trial tactics, if counsel knows opposing counsel has an fMRI expert waiting in the wings to rehabilitate the witness should impeachment charge the witness with lying, she may wish to either forego impeachment or rely upon a method that does not raise the specter of deliberate fabrication.

The rehabilitation by introducing expert opinion of the fMRI scan raises the initial question of whether the statements made by the witness during the scan are admissible as substantive evidence. If the statements themselves are offered for the truth of the matter asserted, the statements are hearsay and only admissible as substantive evidence if they meet an exemption or exception to the

truthfulness as contemplated by Rule 608(a). *See supra* notes 105–25 and accompanying text.

¹⁵⁹ *See supra* notes 95–158 and accompanying text.

¹⁶⁰ *See supra* notes 95–96 and accompanying text for a discussion of the requirement that evidence offered to rehabilitate a witness after impeachment must correspond to the nature of the impeachment itself.

hearsay rule. Federal Rule of Evidence 801(d)(1)(B) exempts from the definition of hearsay prior consistent statements of a testifying witness offered to rebut an express or implied charge that the in-court testimony was of recent fabrication or the product of an improper motive or influence. In *Tome v. United States*,¹⁶¹ the Supreme Court held that only statements made before the alleged motive to fabricate or improper influence arose are admissible under Rule 801(d)(1)(B).¹⁶² The typical fMRI examination will usually occur long after any motive to fabricate arose. Otherwise, there would be no need for the fMRI-based opinion.

¹⁶¹ 513 U.S. 150 (1995).

¹⁶² Application of the pre-motive requirement to Rule 801(d)(1)(B) was not without some controversy. See, e.g., Eileen A. Scallen, *Classical Rhetoric, Practical Reasoning, and the Law of Evidence*, 44 AM. U. L. REV. 1717 (1995); Andrew E. Taslitz, *Interpretive Method and the Federal Rules of Evidence: A Call for a Politically Realistic Hermeneutics*, 32 HARV. J. LEGIS. 329 (1995). Others have called for amending Rule 801(d)(1)(B) to allow all prior statements that are relevant for rehabilitation to be admitted for substantive purposes without regard to when the alleged motive to fabricate arose. Hon. Frank W. Bullock, Jr., & Steven Gardner, *Prior Consistent Statements and the Premotive Rule*, 24 FLA. ST. U. L. REV. 509 (1997). This argument has gained considerable traction and the Supreme Court forwarded to Congress a recommendation to change to Rule 801(d)(1)(B) to admit prior consistent statements as substantive evidence without regard to the pre-motive requirement if they are otherwise relevant to rehabilitate the witness. The amendment to Rule 801(d)(1)(B) will become effective on Dec. 1, 2014, unless Congress takes contrary action. See Supreme Court of the United States Order Apr. 25, 2014, amending FRE 801(d)(1)(B) and 803(6)–(8) available at http://www.supremecourt.gov/orders/courtorders/frev14_3318.pdf (last visited May 12, 2014). One commentator has argued that the rule against hearsay stands as the major obstacle to the admissibility of scientifically valid fMRI-based expert testimony on witness truthfulness. Jeffrey Bellin, *The Significance (if any) for the Federal Criminal Justice System of Advances in Lie Detector Technology*, 80 TEMP. L. REV. 711, 727 (2007) (“The most cogent evidentiary objection to scientifically valid expert lie detector testimony is that it is hearsay.”). The pending amendment to Rule 801(d)(1)(B) eliminates this argument. Some states freely admit prior consistent statements of testifying witnesses for the non-hearsay purpose of corroboration of the witness’s in-court testimony. See, e.g., *State v. Garcell*, 363 N.C. 10, 39–40, 678 S.E.2d 618, 637 (N.C. 2009) (admitting prior statements of testifying witnesses given to police during station house interview as “corroborative evidence”).

If the statements of the witness made during the scan are not offered for their truth value but are only offered as a basis of the expert's opinion, or for other non-truth purposes, neither the hearsay rule nor the pre-motive requirement presents a problem. Experts may rely upon otherwise inadmissible evidence "if experts in the particular field would reasonably rely on those kinds of facts or data in forming an opinion on the subject"¹⁶³ Obviously, fMRI experts on witness truthfulness would all rely upon the MRI data generated by the witness's statements during the scan. The actual statements of the witness in answering "yes" or "no" to the questions about the incident are not what the opinion is based upon in the first instance. It is the BOLD response those statements generate that is the basis of the opinion of truthfulness. Furthermore, in the typical scan the examiner will go through the questions twice, once instructing the witness to lie and once instructing the witness to tell the truth. Only if the BOLD response during the "truth" scan is less than the response during the "lie" scan does it indicate deception.¹⁶⁴ Accordingly, the hearsay rule and the pre-motive requirement of Rule 801(d)(1)(B) do not present a serious obstacle to fMRI-based opinions of truthfulness.

To summarize how the rules regulating impeachment and rehabilitation of witnesses at trial apply to the fMRI-based expert opinion on truthfulness we can say: (1) fMRI-based expert opinion testimony that the witness testified *truthfully* is not admissible unless and until the witness has testified and been impeached in a way that constitutes an attack on the veracity of the in-court testimony; (2) whether the witness has been impeached in a way that constitutes an attack on the veracity of the in-court testimony is a matter within the discretion of the trial judge; and (3) whether a party can impeach a witness through extrinsic evidence that the witness *failed* an fMRI examination is not prohibited by the

¹⁶³ FED. R. EVID. 703.

¹⁶⁴ Spence, *supra* note 46, at 12.

Federal Rules of Evidence and is a matter left within the discretion of the trial judge.¹⁶⁵

The common theme running through these three principles is that admissibility of the fMRI-based expert opinion is influenced greatly by the trial strategy and tactics of the opponent and is ultimately within the broad discretion of the trial judge. Only time will tell whether litigants will spend the time and money to obtain fMRI opinions when their ultimate admissibility depends upon factors largely beyond their control. What is known, however, is that the rules applicable to impeachment and rehabilitation of witnesses will place some real constraints on the admissibility of fMRI-based evidence of witness truthfulness. In light of the prevailing judicial attitude that excludes expert testimony of witness truthfulness,¹⁶⁶ coupled with the regulation of impeachment and rehabilitation, the opportunities to offer fMRI-based testimony on witness truthfulness are limited.¹⁶⁷

V. RULES OF EVIDENCE: EXPERT OPINION TESTIMONY

To this point we have assumed that the fMRI expert opinion satisfied the standards for expert testimony and did not run afoul of

¹⁶⁵ A jurisdiction may have a *per se* ban on polygraph evidence and if fMRI is included within the scope of that ban, the judge would not have the discretion to admit the fMRI evidence. See, e.g., MIL R. EVID. 707 (banning polygraph evidence). No jurisdiction to date has specifically addressed whether fMRI lie detection is within the scope of a ban on "polygraph" evidence.

¹⁶⁶ See *infra* notes 287–312 and accompanying text for a discussion of the prevailing judicial attitude toward admitting expert testimony on witness truthfulness.

¹⁶⁷ Of course, admission at trial to rehabilitate a witness is not the sole use of fMRI-based expert opinion on truthfulness. As is true with regards to polygraph evidence, the fact that the witness underwent the examination and was found truthful by the expert may be useful in negotiating the disposition of the case with the prosecutor. Furthermore, if opposing counsel is aware of this evidence he may forego an impeachment that would rise to the level of an attack on veracity in order to avoid the issue. Both uses have utility. The question is whether fMRI-based evidence is worth the time and expense when its ultimate use is so difficult to predict and, in large measure, dependent upon the trial strategy of the opponent.

Rule 403. When those two standards are coupled with the rules regulating impeachment and rehabilitation, the likelihood of the jury hearing from the fMRI expert is reduced further. The next sections address those limitations.

A. *Rule 702: The Relevant and Reliable Standard*

Generally, the rules of evidence in both state and federal courts require witnesses to testify based on their first-hand knowledge of the historical facts and do not permit, with certain exceptions, opinion testimony.¹⁶⁸ The major exception is when the testimony is based on scientific, technical or other specialized knowledge.¹⁶⁹ Rules 702 through 705 of the Federal Rules of Evidence govern the admissibility of this important category of evidence in federal trials. Trials in state court are governed by the various state rules of evidence, which may or may not mirror the standards of the federal rules. Because the fMRI image only reveals brain activity based on the BOLD response while the subject is undergoing some cognitive task, explaining what a given image means with regard to the subject's truthfulness requires expert opinion testimony.

The Supreme Court set out a two-prong test for admissibility under Rule 702 in *Daubert v. Merrell Dow Pharmaceuticals, Inc.*¹⁷⁰ In *Daubert*, the Court rejected the *Frye v. United States*¹⁷¹

¹⁶⁸ FED. R. EVID. 602; FED. R. EVID. 701. Lay witnesses (non-experts) are permitted to testify in the form of an opinion if the opinion is "(a) rationally based on the witness's perception; (b) helpful to clearly understanding the witness's testimony or to determining a fact in issues; and (c) not based on scientific, technical, or other specialized knowledge within the scope of Rule 702." FED. R. EVID. 701.

¹⁶⁹ FED. R. EVID. 701.

¹⁷⁰ 509 U.S. 579 (1993). Rule 702, as it existed at the time *Daubert* was decided, read, "[i]f scientific, technical, or other specialized knowledge will assist the trier of fact to understand the evidence or to determine a fact in issue, a witness qualified as an expert by knowledge, skill experience, training, or education, may testify thereto in the form of an opinion or otherwise." FED. R. EVID. 702 (1993) (amended 2000). *Daubert* and its progeny have been the subject of too many articles and publications to count. For a summary of the case and its impact on the law of expert testimony, see, e.g., Robert Robinson, *Daubert v. Merrell Dow Pharmaceuticals and the Local Construction of Reliability*,

standard of admitting expert testimony if the relevant scientific community generally accepted the scientific theory underlying the testimony and held that Rule 702 requires the trial judge to “ensure that any and all scientific testimony or evidence admitted is not only relevant, but reliable.”¹⁷²

The *Daubert* Court found the relevance standard embodied in Rule 702’s requirement that expert opinion evidence “assist the trier of fact to understand the evidence or to determine a fact in issue.”¹⁷³ This helpfulness standard requires a valid scientific connection, or “fit,” between the opinion and a disputed issue in the case.¹⁷⁴ Specifically, “Rule 702’s ‘helpfulness’ standard requires a valid scientific connection to the pertinent inquiry as a precondition to admissibility.”¹⁷⁵

The reliability prong of the Rule 702 standard finds its locus in the “scientific . . . knowledge” language of the rule.¹⁷⁶ The court

19 ALB. L.J. SCI. & TECH. 39 (2009); David E. Bernstein, *The Admissibility of Scientific Evidence After Daubert v. Merrell Dow Pharmaceuticals, Inc.*, 15 CARDOZO L. REV. 2139 (1999); Judge Harvey Brown, *Eight Gates for Expert Witnesses*, 36 HOUS. L. REV. 743 (1999); Ruth Saunders, *The Circuit Courts’ Application of Daubert v. Merrell Dow Pharmaceuticals, Inc.*, 46 DRAKE L. REV. 407 (1997).

¹⁷¹ 293 F. 1013 (D.C. Cir. 1923). Like *Daubert*, the *Frye* decision has been the subject of extensive scholarly commentary. See, e.g., Steven M. Egesdal, *The Frye Doctrine and Relevancy Approach Controversy: An Empirical Evaluation*, 74 GEO. L.J. 1769 (1986); John R. Waltz, *Judicial Discretion in the Admission of Evidence Under the Federal Rules of Evidence*, 79 NW. U. L. REV. 1097 (1984); Edward J. Imwinkelried, *A New Era in The Evolution of Scientific Evidence—A Primer on Evaluating The Weight of Scientific Evidence*, 23 WM. & MARY L. REV. 261 (1981); Paul C. Giannelli, *The Admissibility of Novel Scientific Evidence: Frye v. United States, a Half-Century Later*, 80 COLUM. L. REV. 1197 (1980).

¹⁷² *Daubert*, 509 U.S. at 589 (“Given the Rules’ permissive backdrop and their inclusions of a specific rule on expert testimony that does not mention ‘general acceptance,’ the assertion that the Rules somehow assimilated *Frye* is unconvincing.”).

¹⁷³ *Id.* at 591.

¹⁷⁴ *Id.* at 591–92.

¹⁷⁵ *Id.*

¹⁷⁶ *Id.* at 590.

defined “scientific knowledge,” as “derived by the scientific method” and supported by “appropriate validation—*i.e.*, ‘good grounds’”¹⁷⁷ The Court explained, “in a case involving scientific evidence, *evidentiary reliability* will be based upon *scientific validity*.”¹⁷⁸

Federal Rule of Evidence 104(a) (“Rule 104(a)”) places the responsibility on the trial judge to determine “whether the reasoning or methodology underlying the testimony is scientifically valid and . . . whether the reasoning or methodology can be applied to the facts in issue.”¹⁷⁹ The Court suggested five factors for judges to consider: (1) whether the technique or theory can be, or has been, tested in some objective sense; (2) whether the technique or theory has been subject to peer review; (3) the known or potential error rate of the technique or theory when applied; (4) whether there are standards or controls that govern the application of the technique or theory; and (5) whether the technique or theory has been generally accepted by the relevant scientific community.¹⁸⁰

In response to *Daubert*, Rule 702 was amended in 2000 to specifically require expert testimony be based upon sufficient facts and data, be the product of reliable principles and methods, and that the expert applied the principles and methods reliably in

¹⁷⁷ *Id.*

¹⁷⁸ *Id.* at 600, n.9 (emphasis in original).

¹⁷⁹ *Id.* at 592–93.

¹⁸⁰ *Id.* at 593–94. Some courts, like the magistrate judge and the Sixth Circuit in *Semrau*, and commentators combine the “error rate” factor and the existence of “standards or controls” into the same bullet point and list only four *Daubert* factors. Subsequent cases expanded the non-exclusive *Daubert* factors to consider, (6) whether the expert’s testimony is based on information growing out of independent research or was developed for the purpose of litigation, *Daubert v. Merrell Dow Pharm.*, 43 F.3d 1311, 1317 (9th Cir. 1995); (7) whether there is “too great an analytical gap between the data and the opinion proffered,” *General Elec. Co. v. Joiner*, 522 U.S. 136, 146 (1997); (8) whether alternative explanations have been considered and accounted for, *Claar v. Burlington N.R.R.*, 29 F.3d 499 (9th Cir. 1994); (9) whether the expert has applied the same care and attention to his paid litigation consulting that he applies to his regular professional practice, *Kumho Tire Co. v. Carmichael*, 526 U.S. 137, 151–53 (1999).

reaching his opinion.¹⁸¹ As noted by the Advisory Committee, in proposing the 2000 amendment, “[n]o attempt has been made to ‘codify’ [the *Daubert* factors] The standards set forth in the amendment are broad enough to require consideration of any or all of the specific *Daubert* factors where appropriate.”¹⁸² The Advisory Committee also made clear that the admissibility of expert testimony is purely a matter for the trial court under Rule 104(a) and that the proponent of the testimony has the burden of establishing by a preponderance of the evidence that all of the admissibility requirements have been satisfied.¹⁸³

Like *Daubert*, the 2000 amendment to Rule 702, did not impose a checklist of factors that must be applied in each case. Rather, the rule set out a framework to analyze whether the proffered testimony is relevant and reliable to address the issues at trial. The allure of a checklist, however, has proven too much for some courts to resist. In performing their gatekeeping functions, many courts cite to Rule 702 and then proceed to analyze the admissibility of the proffered testimony under the *Daubert* factors without considering the analytical framework of Rule 702. The *Daubert* factors have, in many instances, become a proxy for the analysis of the scientific validity of the principles and methods underlying an opinion. Some courts, however, have recognized

¹⁸¹ Rule 702 reads:

Rule 702. Testimony by Expert Witnesses

A witness who is qualified as an expert by knowledge, skill, experience, training, or education may testify in the form of an opinion or otherwise if:

- (a) the expert’s scientific, technical, or other specialized knowledge will help the trier of fact to understand the evidence or to determine a fact in issue;
- (b) the testimony is based on sufficient facts or data;
- (c) the testimony is the product of reliable principles and methods; and
- (d) the expert has reliably applied the principles and methods to the facts of the case.

FED. R. EVID. 702.

¹⁸² *Id.* advisory committee’s note to 2000 amendment.

¹⁸³ *Id.*

that the 2000 amendment to Rule 702 superseded the *Daubert* decision but the *Daubert* decision serves as the foundation for the rule.¹⁸⁴

B. Evidence of Lies: Judicial Scrutiny of fMRI Expert Opinion on Truthfulness

The most detailed judicial scrutiny of fMRI as a truth verifier to date, under Rule 702, is the magistrate judge's Amended Report and Recommendation in *United States v. Semrau*.¹⁸⁵ Dr. Lorne Semrau, a psychologist, was charged with sixty counts of defrauding Medicare, Medicaid, and other health care benefit programs for submitting false reimbursement claims for psychiatric services provided to patients in nursing homes in Tennessee and Mississippi between 1999 and 2005.¹⁸⁶ To convict Dr. Semrau of health care fraud under 18 U.S.C. § 1347, the Government had to prove beyond a reasonable doubt that Dr. Semrau: (1) "knowingly devised a scheme or artifice to defraud a health care benefit program . . . ; (2) executed or attempted to execute this scheme . . . ; and (3) acted with intent to defraud."¹⁸⁷

¹⁸⁴ *United States v. Para*, 402 F.3d 752 (7th Cir. 2005).

¹⁸⁵ *United States v. Semrau*, No. 07-10074, 2010 WL 6845092 (W.D. Tenn. June 1, 2010). The Magistrate Judge's Report and Recommendation, which excluded the fMRI-based testimony, was adopted by the district judge. Out of a 71 count indictment, the jury found Dr. Semrau guilty of three counts Health Care Fraud, Aiding and Abetting, in violation of 18 U.S.C. § 1347. *United States v. Semrau*, No. 1:07CR10074-01-MJ, 2011 WL 1114441, (W.D. Tenn. Mar. 24, 2011). On appeal, the Sixth Circuit affirmed the trial court's exclusion of the fMRI testimony and upheld the conviction. *United States v. Semrau*, 693 F.3d 510 (6th Cir. 2012). The courts in *Wilson v. Corestaff Servs., L.P.*, 28 Misc. 3d 425 (N.Y. Sup. Ct. 2010) and *State v. Smith*, No. 106589C (Cir. Ct. Montgomery Cty., MD, Oct. 3, 2012) excluded the fMRI testimony under the "general acceptance" standard for admission of novel expert testimony in New York and Maryland, respectively, and did not engage in a detailed inquiry into the scientific reliability of the technology.

¹⁸⁶ He was also charged with eleven counts of money laundering, but those charges were not specifically addressed in the fMRI scanning. *United States v. Semrau*, No. 07-10074, 2010 WL 6845092, at *2 (W. D. Tenn. June 1, 2010).

¹⁸⁷ *Id.* at *2 n.4.

Specifically, the government alleged Dr. Semrau “upcoded” his bills for reimbursement by instructing his billing clerks to submit bills for procedure codes that were different than and were reimbursed at a greater rate than the billing codes for the procedures and examinations actually performed by the doctors working for his company.¹⁸⁸ He also submitted separate bills for Abnormal Involuntary Movement Scale (“AIMS”) tests that his psychiatrists performed as part of their regular monitoring of their patients’ condition.¹⁸⁹ The Government charged that Dr. Semrau knew that AIMS tests were part of the routine monitoring and were not to be billed separately.¹⁹⁰

Dr. Semrau contested the Government’s claim that he “knowingly” devised a scheme to defraud, denying that he “acted with intent to defraud.”¹⁹¹ He did not dispute that he submitted bills with differing codes than those recorded by the treating physicians in their encounters with the patients. He claimed the procedure codes were confusing and inconsistent and his billing practices were reasonable under the circumstances.¹⁹² Dr. Semrau claimed that representatives of the companies processing the Medicare and Medicaid claims told him that he could submit separate bills for the AIMS tests. Dr. Semrau’s defense was that he did not intend to defraud the government when he submitted the bills between 1999 and 2005.¹⁹³

To bolster the credibility of his denial of the intent to defraud, Dr. Semrau underwent fMRI scanning conducted by Dr. Steven J. Laken, Ph.D., founder and president of Cephos Corporation, a company that provided lie detection and truth verification services using fMRI.¹⁹⁴

¹⁸⁸ *Id.* at *2.

¹⁸⁹ *Id.*

¹⁹⁰ *Id.* at *2 n.4.

¹⁹¹ *Id.* at *2.

¹⁹² *Id.*

¹⁹³ *Id.*

¹⁹⁴ *Id.* at *4–7; CEPHOS CORP., <http://www.cephoscorp.com/about-us/index.php#about> (last visited Sep. 6, 2010). Cephos Corp. discontinued their lie detection and truth verification services in early 2013. The current version of the

Dr. Semrau's counsel contacted Dr. Laken in December 2009, and arranged for Dr. Laken to perform fMRI scanning to determine whether Dr. Semrau was truthful when he denied having the intent to defraud the government.¹⁹⁵ Dr. Laken worked with the defense counsel to develop Specific Incident Questions ("SIQ") related to the charged offenses.¹⁹⁶ The SIQs dealt with the basic facts alleged in the indictment, including whether Dr. Semrau intended to defraud the government by submitting his claims for reimbursement, and were phrased to elicit a "yes" or "no" response.¹⁹⁷ For the purposes of the fMRI, the charges were divided into two major areas.¹⁹⁸ The first area focused on whether Dr. Semrau was telling the truth when he denied submitting the reimbursement bills with an intent to defraud.¹⁹⁹ The second area focused on whether he knew that AIMS tests were not to be billed separately.²⁰⁰

On December 30, 2009, Dr. Semrau traveled to Dr. Laken's lab in Massachusetts.²⁰¹ After a medical exam and preliminary tests to determine whether any impediments to scanning existed, Dr. Laken went over the procedures and the SIQs with Dr. Semrau.²⁰² Prior to the scan, Dr. Semrau practiced answering the SIQs on a computer to become familiar with them and the response device he

company's website does not mention or refer to the fMRI truth verification services previously offered by Cephus. In an email exchange with the author, Dr. Laken expressed frustration with the reluctance of the legal system to accept what he believed was highly reliable evidence of truthfulness. His company now devotes its time and resources to forensic DNA services. Personal communication with Dr. Laken, on file with the author.

¹⁹⁵ United States v. Semrau, No. 07-10074, 2010 WL 6845092, at *4 (W.D. Tenn. June 1, 2010).

¹⁹⁶ *Id.*

¹⁹⁷ *Id.*

¹⁹⁸ *Id.*

¹⁹⁹ *Id.* at *4-5.

²⁰⁰ *Id.* at *5-6.

²⁰¹ Dr. Laken's company covered all the expenses associated with the fMRI scanning including Dr. Laken's time and travel to testify at the hearing. United States v. Semrau, No. 07-10074, 2010 WL 6845092, at *4 n.12 (W.D. Tenn. June 1, 2010).

²⁰² *Id.* at *4-7.

would be using while in the scanner.²⁰³ The first scan dealt with the intent to defraud issue.²⁰⁴ Dr. Semrau entered the scanner and responded to the randomized presentation of the SIQs.²⁰⁵ He was first instructed to respond truthfully to each question.²⁰⁶ The questions were presented again and this time he was instructed to respond falsely.²⁰⁷

After the scans on the intent issue, Dr. Semrau told Dr. Laken he was tired but felt capable of continuing.²⁰⁸ Dr. Laken then scanned him while he responded to the SIQs dealing with the AIMS testing issue.²⁰⁹ As before, he was told to respond truthfully the first time through and falsely the second time.²¹⁰ At the conclusion of the second scan, Dr. Semrau again mentioned he was tired and that the SIQs seemed complex and confusing, even though he had practiced them before getting in the scanner.²¹¹

After all the scans were completed, Dr. Laken processed the data through his proprietary computer program and evaluated the resulting images.²¹² By comparing the BOLD responses between the two scans on the intent issues Dr. Laken concluded that Dr. Semrau was being truthful during the scan, in which he denied having the intent to defraud when he submitted the claims for reimbursement.²¹³

On the scan dealing with the AIMS tests, however, the BOLD response indicated deception.²¹⁴ Dr. Laken surmised that fatigue and the confusing and complex nature of the AIMS SIQs were

²⁰³ *Id.* at *6.

²⁰⁴ *Id.*

²⁰⁵ *Id.*

²⁰⁶ *Id.*

²⁰⁷ *Id.*

²⁰⁸ *Id.*

²⁰⁹ *Id.*

²¹⁰ *Id.*

²¹¹ *Id.*

²¹² *Id.*

²¹³ *Id.* at *7.

²¹⁴ *Id.*

responsible for the deception finding.²¹⁵ After revising the SIQs dealing with the AIMS test, Dr. Laken arranged for Dr. Semrau to return to Massachusetts to repeat the AIMS test scan.²¹⁶ After processing the data from the repeat scans, Dr. Laken concluded that Dr. Semrau was being truthful when he denied knowing that it was improper to seek reimbursement for AIMS tests as separate items.²¹⁷

Dr. Semrau's counsel notified the government that Dr. Laken was prepared to testify that Dr. Semrau was telling the truth when he denied having the intent to defraud the government and that he did not know submitting separate bills for AIMS testing was inappropriate.²¹⁸ The government moved to exclude Dr. Laken's testimony under Rules 702 and 403.²¹⁹ On May 13 and 14, 2010, the magistrate judge conducted a hearing on the government's motion. Dr. Laken testified to the reliability of fMRI as a truth verification technology and offered affidavits of other scientists and scientific literature to support his theory.²²⁰ The government called two experts of its own to dispute the reliability issue of fMRI-based opinion testimony on truthfulness generally, and on the specific application to Dr. Semrau, offering scientific and legal literature that questioned the reliability of fMRI as a lie detector.²²¹

In his report recommending exclusion of Dr. Laken's expert opinion, the magistrate judge analyzed the testimony and exhibits presented at the hearing in light of the *Daubert* factors.²²² First, he

²¹⁵ *Id.*

²¹⁶ *Id.*

²¹⁷ *Id.*

²¹⁸ *Id.* at *1.

²¹⁹ *Id.*

²²⁰ *Id.*

²²¹ *Id.*

²²² *Id.* at *9–14. By combining the known or potential error rate and the existence of protocols or standards into one inquiry, the magistrate judge read *Daubert* as suggesting four factors instead of five. Obviously, fMRI as a truth verifier is based upon scientific knowledge and the magistrate judge first found that Dr. Laken's was qualified to offer an opinion based on his experience, education, and training. *Id.* at *10. Not mentioned in the analysis under Rule 702 was the requirement that the testimony "assist the trier of fact," though

considered whether the underlying principles can be and have been tested.²²³ He found the underlying theories of fMRI-based lie detection had been subjected to laboratory testing “at some level.”²²⁴ He noted, however, that only three of the laboratory studies attempted to determine whether fMRI could accurately detect deception in individuals as opposed to looking at average BOLD responses across the group of subjects in a given study.²²⁵ The first *Daubert* factor could only be satisfied by Dr. Laken’s limited work in his laboratory, rather than any implementation of the fMRI technology in the real world.²²⁶ In fact, Dr. Laken acknowledged that he did not know how fMRI for lie detection could be tested in a real-world setting.²²⁷

The magistrate judge also found theories supporting fMRI as a lie detector have been published in peer reviewed scientific publications, though the studies upon which the articles were based

Magistrate Judge Pham did allude to that requirement in his Rule 403 analysis. *Id.* at *16. Furthermore, Magistrate Judge Pham found it unnecessary to address the “relevance prong” of FED. R. EVID. 702 because he found the opinion testimony unreliable under the *Daubert* factors.

²²³ *Id.* at *9.

²²⁴ *Id.* at *10.

²²⁵ *Id.* at *10 n.16. In the typical fMRI study, all of the subjects are scanned and the voxel activation pattern is averaged across the group to identify the regions of the brain where the BOLD response is greatest. Because the final image is a group average of the scan data across all the subjects, it may not represent the actual activation pattern in any single individual. *See* Aguirre, *supra* note 40, at 2.

²²⁶ *United States v. Semrau*, No. 07–10074, 2010 WL 6845092, at *10 (W.D. Tenn. June 1, 2010).

²²⁷ Testimony of Steven Laken, Transcript of Proceedings, May 13, 2010, Vol. II at 191, *United States v. Semrau*, No. 07CR10074-1JPM (W.D. Tenn.). The applicability of a laboratory study to outside persons in different settings involve problems of external validity and ecological validity. These validities concern how well the laboratory findings translate to people and situations as they occur in the dynamics of everyday life as opposed to the controlled environment of the scientific laboratory. *See infra* notes 478–95 (discussing external and ecological validity of fMRI studies on detecting deception).

were conducted only in laboratory settings.²²⁸ He noted several additional studies analyzing fMRI in the lie detection context have been published since 2008.²²⁹

The lack of known error rates for an fMRI lie detector in a real-world application, especially as applied to a sixty-three year-old subject, raised additional concerns about the reliability of the opinion.²³⁰ While Dr. Laken testified at the *Daubert* hearing that known error rates could be calculated from the fMRI studies upon which he relied, a government expert disputed the doctor's claim by pointing to the sample sizes of the existing studies, which were too small to draw statistically significant error rates.²³¹ Furthermore, it was undisputed that there were no known error rates, or even efforts to discover them, in any setting beyond the laboratory using.²³² In addition, Dr. Semrau's age at the time of the scan was outside the eighteen to fifty-year-old used by Dr. Laken to establish his error rates.²³³ The small sample sizes Dr. Laken relied on,²³⁴ coupled with the complete absence of any known error rates in a real world applications for sixty-three year-old subjects,²³⁵ and conclusions in the scientific literature from other researchers that "[fMRI] is currently not ready to be used in real-world lie detection"²³⁶ seriously impeded Dr. Semrau's efforts to convince the magistrate judge that Dr. Laken's opinion was reliable.

Similarly, the lack of any established protocols or controls in the real-world application of fMRI as a lie detector were held as negative factors against admitting Dr. Laken's testimony.²³⁷ Dr. Laken did testify that he used his own protocols and control, but

²²⁸ United States v. Semrau, No. 07-10074, 2010 WL 6845092, at *10 (W. D. Tenn. June 1, 2010).

²²⁹ *Id.* at *10 n.16.

²³⁰ *Id.* at *11.

²³¹ *Id.*

²³² *Id.*

²³³ *Id.* at *12 n.17.

²³⁴ *Id.* at *11.

²³⁵ *Id.* at *12 n.17.

²³⁶ *Id.* at *12.

²³⁷ *Id.* at *13.

there were no uniform industry standards applicable to real world testing.²³⁸ “Without such standards,” the magistrate judge found, “a court cannot adequately evaluate the reliability of a particular lie detection examination.”²³⁹

The magistrate judge also found that Dr. Laken likely departed from his own self-developed protocols.²⁴⁰ If the deception finding on the initial scan regarding AIMS testing was caused by Dr. Semrau’s fatigue, as Dr. Laken testified, it was an indication that Dr. Laken either did not have a reliable protocol for developing proper SIQs, or he failed to follow an established reliable protocol.²⁴¹ If the outcome of a scan varies with the form of the questions, it would seem that scientific reliability would require a rather clear and precise protocol for question format. None of the published studies of fMRI scans for truth verification have indicated any efforts to test what effect, if any, the form of the SIQ has on the outcome. The magistrate judge was not comfortable with a procedure that led to a deception finding based on flawed SIQs and fatigue, and a methodology calling for repeat scans with revised SIQs until the results supported the client’s claim.²⁴² Thus, the lack of standards and failure to follow protocols seriously undermined the reliability of Dr. Laken’s opinions.

Finally, the magistrate judge evaluated the level of acceptance of fMRI as a lie detector in the neuroscience community.²⁴³ Dr. Laken admitted at the *Daubert* hearing that another court excluded his fMRI opinion regarding truthfulness in a civil case. That court applied the *Frye* general acceptance test and found that fMRI as a lie detector was not generally accepted by the neuroscience community.²⁴⁴ The magistrate judge, relying upon experts in the field, found that fMRI as a means to detect deception is not

²³⁸ *Id.*

²³⁹ *Id.*

²⁴⁰ *Id.* at *7.

²⁴¹ *Id.*

²⁴² *Id.*

²⁴³ *Id.* at *3 n.7.

²⁴⁴ *Wilson v. Corestaff Servs., L.P.*, 28 Misc. 3d 425 (N.Y. Sup. Ct. 2010).

generally accepted by the neuroscience community as a scientifically sound and reliable way to detect lies in a real world setting.²⁴⁵

The magistrate judge concluded that Dr. Laken's testimony failed the reliability prong of Rule 702 and recommended the District Court grant the government's motion to exclude the evidence.²⁴⁶ As a result, the magistrate judge did not evaluate the relevance or "fit" requirement of the Rule.²⁴⁷

The district judge adopted the Magistrate Judge's Report and Recommendation and excluded Dr. Laken's testimony. Dr. Semrau was ultimately convicted of three counts of healthcare fraud.²⁴⁸ The Sixth Circuit affirmed his conviction and held the District Court did not abuse its discretion in excluding Dr. Laken's testimony under Rule 702 for the reasons set out in the Magistrate Judge's Report and Recommendation.²⁴⁹

Because the Magistrate and District Court did not consider the "fit" aspect of Rule 702, neither did the Sixth Circuit. The appellate court noted, however, that jurors without advanced scientific degrees and training would be "poorly suited" to weigh the importance of the distinctions between past studies in the field and the specifics of the exam administered to Dr. Semrau.²⁵⁰ The

²⁴⁵ *Semrau*, 2010 WL 6845092, at *13.

²⁴⁶ *Id.* at *14.

²⁴⁷ The magistrate judge noted that Dr. Laken's opinion spoke to Dr. Semrau's "overall" truthfulness and not to the validity of any individual SIQ. *Id.* at *5 n.15. The first sixty counts of the indictment all alleged violations of 18 U.S.C. § 1347 in submission of claims for reimbursement on specific dates to specific third party payors. *Id.* at *2. Specifically, the government alleged Dr. Semrau submitted reimbursement claims under Code 99312 instead of Code 90862 with an intent to defraud. *Id.* One of the SIQs asked, "Did you bill CPT Code 99312 to cheat or defraud Medicare?" *Id.* at *5. Dr. Laken could not offer an opinion on whether Dr. Semrau was lying or telling the truth when he said, "No," in response to that question. *Id.* at *8.

²⁴⁸ *United States v. Semrau*, 693 F.3d 510, 531 (6th Cir. 2012).

²⁴⁹ *Id.* at 523.

²⁵⁰ *Id.*

judge decided that jurors would “more likely . . . be confused rather than assisted by Dr. Laken’s testimony.”²⁵¹

C. *Evidence of Lies: Analyzing Expert Opinion on Truthfulness*

The magistrate judge and the Sixth Circuit in *Semrau* resolved the admissibility of Dr. Laken’s opinion on a rather straightforward application of the *Daubert* factors. They were, after all, reviewing the evidence and argument of counsel in a specific case and were not engaged in a general academic inquiry as to the reliability of fMRI. Precisely because the *Semrau* court did not delve deeper than the record before it required, some additional evaluation of fMRI lie detection’s relevance and reliability is appropriate.

fMRI as a lie detector or truth verifier is in its infancy. It is hardly surprising that the first three courts to consider its admissibility rejected it. As the technology improves and its application to deception is refined, other lawyers are likely to offer it into evidence and other courts will have to determine its admissibility. Thus, a closer look at the current state of the science and the legal standards for expert testimony will assist researchers, lawyers, and judges when that day arrives.

While the *Daubert* factors are a useful proxy for assessing reliability in many cases, the admissibility question under Rule 702 is broader than just the *Daubert* factors. The Federal Rules of Evidence impose six conditions on the admission of expert opinion testimony: (1) the witness must be qualified expert in the field by virtue of knowledge, skill, experience, training, or education; (2) the subject matter of the testimony must deal with scientific, technical or other specialized knowledge; (3) the testimony must help the trier of fact to understand the evidence or determine a fact in issue; (4) the witness must have had sufficient facts and data upon which to base an opinion in the specialized field; (5) the principles and methods relied upon by the expert must be reliable when applied to the question presented; and (6) the witness must

²⁵¹ *Id.*

have applied those reliable principles and methods reliably to the facts and data needed to answer the question in the case at hand.²⁵²

The magistrate judge in *Semrau* did note that Dr. Laken met the “qualifications” requirement of Rule 702 and the subject matter dealt with “scientific, technical, or specialized knowledge.”²⁵³ None of these factors were disputed by the government.²⁵⁴ With regard to the remaining four Rule 702 requirements, and like many other courts facing similar issues, the magistrate judge cited Rule 702 for the general proposition that expert testimony must be relevant and reliable and turned immediately to the *Daubert* factors.²⁵⁵

²⁵² FED. R. EVID. 701(c); 702. The requirement that the subject matter deal with scientific, technical or other specialized knowledge is found in the text of Rule 701(c); the other five requirements are found in the text of Rule 702.

²⁵³ *United States v. Semrau*, No. 07–10074, 2010 WL 6845092, at *10 (W.D. Tenn. June 1, 2010).

²⁵⁴ *Id.*

²⁵⁵ *See id.* Some courts have viewed *Daubert* as the last word in the admissibility of expert testimony and have ignored the other two cases in the *Daubert* trilogy, *Joiner* and *Kumho Tire*, as well as the amendments to Rule 702. *See* David Bernstein, *The Misbegotten Judicial Resistance to the Daubert Revolution*, 89 NOTRE DAME L. REV. 27, 29 (2013) (“These judges ignore the text of Rule 702, and instead rely on lenient precedents that predate (and conflict with) not only with the text of amended Rule 702 but also some or all of the *Daubert* trilogy.”). Others have suggested that the three-prong inquiry into the sufficiency of the facts and data, the reliability of the principles and methods, and the reliable application of those principles and methods to the issue at hand as set out in Rule 702 (b), (c), and (d) are no more exacting than the Court’s *Daubert* analysis and should be viewed as a single question. MICHAEL H. GRAHAM, 5 HANDBOOK OF FEDERAL EVIDENCE, § 702.5 (7th ed.) (The following articulation combining three numbered separate requirements of Rule 702 is suggested: “[a]s actually applied in the matter at hand to facts, data, or opinions sufficiently established to exist, are there sufficient assurances of trustworthiness present that the expert witness’ explanative theory produces a correct result to warrant jury acceptance?”). This may explain why some courts reviewing the admissibility of expert testimony cite Rule 702 and then proceed immediately to review the testimony under the *Daubert* factors, much like the magistrate judge and the Sixth Circuit did in *Semrau*. Others have noted that the amendments to Rule 702 imposed a more exacting inquiry into the basis of the proffered testimony and consider each of the subsections of Rule 702 as distinct requirements imposed by the language of the Rule. *See, e.g.,* *Rudd v. General Motors Corp.*, 127 F. Supp. 2d 1330, 1337 (M.D. Ala. 2001) (“[T]he plain

However, analyzing the admissibility of fMRI-based testimony on credibility through the analytical framework suggested by the text of Rule 702 reveals important considerations that were not specifically addressed in either the Magistrate Judge's Report and Recommendation or in the Sixth Circuit's opinion in *Semrau*. Using this case as the factual context, the following sections apply the Rule 702 textual framework to fMRI-based expert opinion testimony on witness truthfulness.

1. *The Qualifications of the Expert Witness*

A witness offering expert opinion testimony must have knowledge, skill, experience, training, or education sufficient to enable him to apply his area of expertise to the issues before the court.²⁵⁶ In *Semrau*, for example, Dr. Laken's qualifications as an expert in fMRI research were undisputed, and the government conceded that he was otherwise qualified.²⁵⁷ That may not be true in every case, and careful litigants should always verify the qualifications of the experts. The qualifications set forth in the Rule are in the disjunctive, and the witness need not have gained his knowledge through higher education; practical experience may, in an appropriate case, suffice.²⁵⁸ In the realm of neuroscience and

language of the new Rule 702, as well as the advisory committee notes to the new Rule, makes it clear that this court is now obliged to screen expert testimony to ensure it stems from, not just a reliable methodology, but also a sufficient factual basis and reliable application of the methodology to the facts.") (emphasis in original). This is not to suggest that Rule 702 displace the *Daubert* factors. On the contrary, the Court's non-exclusive list of factors to consider in assessing the reliability of expert testimony are just as useful after the 2000 amendment as they were before the amendment. In sum, Rule 702 is not satisfied by merely applying the *Daubert* factors without considering the other requirements of the rule.

²⁵⁶ FED. R. EVID. 702(a).

²⁵⁷ *United States v. Semrau*, No. 07-10074, 2010 WL 6845092, at *10 (W.D. Tenn. June 1, 2010).

²⁵⁸ In a case dealing with whether the brakes on a car were defective, the brake mechanic at the local garage who dropped out of high school but who has thirty years' experience fixing brakes and a PhD in automotive engineering may both qualify as expert witnesses. Equally important, experts from different scientific or technical disciplines may employ principles and methods from their

fMRI, however, higher education, as well as training and experience, will be necessary to qualify a witness to give an opinion. A trial lawyer overlooks the qualification issue of his or her own expert, as well as her opponent's experts, at his or her peril. Following the analytical framework embodied in the text of Rule 702 ensures this important consideration is not overlooked.

2. *The Appropriateness of the Subject Matter*

The next issue is whether the subject matter is appropriate for opinion testimony. The Federal Rules of Evidence distinguish between opinions offered by lay witnesses and those offered by experts.²⁵⁹ Rule 701 permits opinion testimony of lay witnesses if (1) the opinion is based on the rational perception of the witness; (2) admitting the opinion would help the jury understand the witness's testimony or determine a fact in issue; and (3) the opinion is not based on scientific, technical, or other specialized knowledge within the meaning of Rule 702.²⁶⁰

Rule 702 picks up where Rule 701 leaves off and requires expert testimony to be based on "scientific, technical, or other specialized knowledge."²⁶¹ Application of Rule 702's limits on permissible subject matter to fMRI generally poses no problem because it is clearly an area of scientific knowledge. While the substantive law does not require litigants to offer fMRI testimony in order to establish a charge, claim, or defense, any expert testimony purporting to apply fMRI technology to an issue in the case obviously requires scientific knowledge.

respective disciplines to the same issue. *See, e.g.,* Smith v. BMW N. Am., Inc., 308 F.3d 913, 919 (8th Cir. 2002) (finding an abuse of discretion in excluding plaintiff's expert forensic pathologist's opinion as to the cause of plaintiff's neck injury in an automobile crash because the witness was not an expert in biomechanics, physics, or engineering like the defendant's expert).

²⁵⁹ FED. R. EVID. 701.

²⁶⁰ *Id.*

²⁶¹ FED. R. EVID. 702(a).

3. *Help the Trier of Fact*

The third condition for admission of expert testimony requires that the opinion assist the jury in its task of historical reconstruction of the events giving rise to the litigation.²⁶² The text of Rule 702(a) puts this factor in terms of understanding other evidence or determining a fact in issue.²⁶³ This limitation on the admissibility of otherwise relevant evidence serves two policy goals: (1) “promote the trier-of-fact’s search for truth by helping it to understand other evidence or determine the facts in dispute,” and (2) “preserve the trier of fact’s traditional power to decide the meaning of evidence and the credibility of witnesses.”²⁶⁴ The *Daubert* Court considered this as an aspect of relevance or “fit” between the opinion and the issue in dispute.²⁶⁵

Relevance is a binary concept: the proffered evidence either has some tendency to make the fact of consequence relevant or irrelevant.²⁶⁶ The “any tendency” standard of Rule 401 is rather easily met and some have even argued that the standard is so low that it is virtually meaningless.²⁶⁷ fMRI-based expert opinion that a witness was truthful in the scanner makes it more likely that in-court testimony consistent with the scanner statements is truthful. While the logical connection between the results of the fMRI scan and the credibility determination at trial is sufficient to pass the low bar of general relevancy, Rule 702’s helpfulness standard demands a closer connection between the underlying science, the opinion, and the issue to be decided. This heightened connection comes after the opinion passes the basic relevancy test applied to

²⁶² *Id.*

²⁶³ *Id.*

²⁶⁴ CHARLES ALAN WRIGHT, KENNETH W. GRAHAM, JR., VICTOR JAMES GOLD, & MICHAEL H. GRAHAM, 29 FEDERAL PRACTICE & PROCEDURE: EVIDENCE § 6262 (2013).

²⁶⁵ *Daubert v. Merrell Dow Pharm, Inc.*, 509 U.S. 579, 591–92 (1993).

²⁶⁶ *Old Chief v. United States*, 519 U.S. 172, 179 n.4 (1997).

²⁶⁷ David Crump, *On the Uses of Irrelevant Evidence*, 34 HOUS. L. REV. 1, 6 (1997) (“[T]he relevancy ‘standard’ in Rule 401 is no standard at all, because it indiscriminately admits every arguable proposition no matter how low its probative value.”).

all evidence under Rule 401, and before weighing the probative value of the opinion versus the prejudicial effect under Rule 403.²⁶⁸

The text of the Federal Rules of Evidence supports this conclusion. Rule 402 declares that evidence meeting the low bar established by Rule 401 is admissible unless otherwise excluded by “these rules”²⁶⁹ Rule 701 excludes opinion testimony based upon scientific, technical, or other specialized knowledge unless it meets all of the standards imposed by Rule 702, including the “help the trier of fact” requirement.²⁷⁰ Rule 702 is one of “these rules” referred to in Rule 402 that excludes evidence that would otherwise pass the relevance test of Rule 401.²⁷¹

Rule 702 requires the proponent of the expert opinion to affirmatively establish the “fit” between the opinion and the facts of the case in order for the opinion to meet the “help the trier of fact” standard.²⁷² If the Rule 702 standard was the same as the Rule 401 general relevance standard, the language in Rule 702(a) requiring expert opinion to help the trier of fact would be superfluous. All evidence must meet the “any tendency” requirement of Rule 401, and all relevant evidence helps the jury to some degree. However, Rule 702(a) uses different language²⁷³ to impose an additional test applicable to expert opinion testimony that has already cleared the low bar of Rule 401 and places the

²⁶⁸ See, e.g., *Daubert*, 509 U.S. at 595 (referring to Rule 403 as another limitation on expert testimony).

²⁶⁹ FED. R. EVID. 402. (“Relevant evidence is admissible unless any of the following provides otherwise: The United States Constitution; a federal statute; these rules; or other rules prescribed by the Supreme Court. Irrelevant evidence is not admissible.”).

²⁷⁰ FED. R. EVID. 702(a)

²⁷¹ By the same token, Rule 403 is also one of “these rules” that excludes evidence that clears other admissibility hurdles.

²⁷² FED. R. EVID. 702 Advisory Committee’s note (explaining that under Rule 104(a), “the proponent has the burden of establishing that the pertinent admissibility requirements are met by a preponderance of the evidence”) (*citing* *Bourjaily v. United States*, 483 U.S. 171 (1987)).

²⁷³ FED. R. EVID. 702(a) (requiring the expert’s knowledge to “help the trier of fact to understand the evidence or to determine a fact in issue”).

burden on the proponent to establish by a preponderance of the evidence that the opinion will help the jury.²⁷⁴

fMRI opinion testimony on truthfulness easily satisfies the “any tendency” standard of Rule 401. Since Rule 401 already requires all admissible evidence to have a tendency to make a fact of consequence more or less probable, the question becomes: what does Rule 702’s helpfulness standard demand in addition to the basic requirement of relevancy?²⁷⁵ The answer requires consideration of the second policy goal embodied in the helpfulness requirement and how courts have treated expert opinion on whether a witness at trial lied or told the truth.

a. *The “Fit” Requirement*

In *Daubert*, the Court addressed this helpfulness aspect of Rule 702 as “whether expert testimony proffered in the case is sufficiently tied to the facts of the case that it will aid the jury in resolving a factual dispute.”²⁷⁶ To meet the helpfulness standard, the Court said it requires “a valid scientific connection to the

²⁷⁴ *Daubert* itself clarified that admissibility of expert opinion was a matter for the court under Rule 104(a). *Daubert v. Merrell Dow Pharm., Inc.*, 509 U.S. 579, 591 (1993). In applying Rule 104(a) to questions of admissibility of evidence, the trial court applies a preponderance of the evidence standard. *Id.* at 592 n.10 (citing *Bourjaily*, 483 U.S. at 175–76). This does not mean, however, that Rule 403 is inoperative when dealing with expert testimony. *Id.* Testimony that satisfies the admissibility standards of Rule 702 may still run afoul of the Rule 403 balancing test and be excluded on that basis. *Id.* at 595.

²⁷⁵ Expert testimony is singled out for special treatment in the discovery rules applicable to both civil and criminal litigation. *See* FED. R. CIV. P. 26; FED. R. CRIM. P. 16(a)(1)(G). It is not surprising that Rule 702 would impose requirements on admissibility in addition to those applicable to non-expert testimony. *See also* DAVID H. KAYE, DAVID E. BERNSTEIN, & JENNIFER L. MNOOKIN, *THE NEW WIGMORE: EXPERT EVIDENCE: WHY ALL EXPERT TESTIMONY SHOULD RECEIVE SERIOUS SCRUTINY* § 10.2 (2d ed. 2013) (rejecting a “let it all in” attitude toward expert testimony and giving four reasons for special scrutiny of expert testimony: (1) avoid wasting time with un-founded areas of expertise; (2) avoid expert shopping by the parties; (3) avoid professional witnesses; and (4) juries lack expertise to fully critique expert opinion).

²⁷⁶ *Daubert*, 509 U.S. at 591 (quoting *United States v. Downing*, 753 F.2d 1224, 1242 (3d Cir. 1985)).

pertinent inquiry as a precondition to admissibility.”²⁷⁷ The “fit” between the expert opinion and the issues before the jury requires more than the basic “any tendency” standard of Rule 401 that applies to all evidence:

The relevancy, or fit, requirement has two important variations in the context of expert testimony. The first refers to the more traditional question of whether the expert’s opinion logically relates to some specific issue in dispute under the substantive law. The second variation, and the one more particular to expert evidence, is whether the research basis for the expert’s opinion generalizes to a legal issue in dispute. Both of these are described as matters of fit, but they typically arise in different ways. The first is primarily a concern of the substantive law and whether the fact that is the subject of the expert testimony is an issue in the case. The second primarily concerns the underlying research basis for the expert opinion and whether it can be extrapolated to help resolve a disputed fact that is an issue in the case.²⁷⁸

Professors David Faigman, John Monahan, and Christopher Slobogin explain the “fit” requirement as consisting of both “legal

²⁷⁷ *Id.* at 592.

²⁷⁸ Faigman, *supra* note 82, at 93; *see also* CHRISTOPHER B. MUELLER AND LAIRD C. KIRKPATRICK, 3 FEDERAL EVIDENCE 787–88 (4th ed. 2013) (“Expert and scientific testimony usually reflects, and brings to bear on the case, theories, tests, and experience generated in situations unrelated to the events in litigation. Hence, its utility turns partly on the degree of resemblance between the transaction in suit and the situations in which the science or expertise was generated. Expert testimony also extrapolates or draws conclusions resting on theories, tests, and experience, and its utility turns in part on how closely the conclusion is connected to the underlying data—whether it is but a short step from data to conclusion or a long inferential leap. The closer the connection the better the fit, although this criterion does not demand there be perfect congruence between proffered testimony and the facts or issues in the case.”); *see also In re Paoli R.R. Yard PCB Litigation*, 35 F.3d 717, 745 (3d Cir. 1994) (“[T]he [fit] standard is higher than bare relevance.”). The relevance prong of Rule 702’s “help the jury” standard also differs from Rule 401 in that the issue addressed by the proffered expert opinion must be “in dispute.” *Daubert*, 509 U.S. at 591. The existence of a factual dispute is not an aspect of relevance under Rule 401. *Old Chief v. United States*, 519 U.S. 172, 179 (1997).

fit” and “empirical fit.”²⁷⁹ Legal fit asks whether the opinion helps the jury determine a “factual question that the substantive law requires to be answered.”²⁸⁰ Empirical fit addresses “whether the expert testimony proffered in the case is based on research methods that relate to the factual question in issue.”²⁸¹ Considering fMRI-based expert opinion on witness truthfulness under this paradigm reveals serious “fit” problems.

i. *Legal Fit*

Legal fit in this paradigm encompasses simple relevancy. Credibility is always a “fact of consequence” within the meaning of Rule 401.²⁸² Furthermore, the opinion of one who professes to have some special or scientific basis upon which to determine truthfulness has some tendency, however slight, to make the truth or falsity of the testimony more or less likely. For example, if one who professes to have a scientific basis upon which to distinguish between truth and lies is of the opinion that the witness told the truth when undergoing that scientific test, it logically follows that testimony at trial consistent with that given during the test is more likely to be true. The opinion does not “prove” the witness is telling the truth, but it has some tendency to make it more likely that the consistent in-court testimony is truthful.

The legal fit inquiry also considers whether the expert testimony addresses a disputed issue the substantive law *requires* the jury to resolve.²⁸³ This goes beyond the mere “any tendency”

²⁷⁹ David L. Faigman, John Mohahan & Christopher Slobogin, *Group to Individual (G2i) Inference in Scientific Expert Testimony*, 81 U. CHI. L. REV. (forthcoming 2014) (manuscript at 23), available at <http://ssrn.com/abstract=2298909>.

²⁸⁰ *Id.*

²⁸¹ *Id.*

²⁸² *Cf.* United States v. Abel, 469 U.S. 45, 52 (1984) (“Proof of bias is almost always relevant because the jury, as finder of fact and weigher of credibility, has historically been entitled to assess all evidence which might bear on the accuracy and truth of a witness’ testimony.”).

²⁸³ *Daubert*, 509 U.S. at 591; see also Faigman, Mohahan & Slobogin, *supra* note 279, at 23 (“Legal fit calls upon courts to determine whether the expert testimony proffered in the case is material to a factual question that the substantive law requires to be answered.”).

standard of Rule 401 and reaches the second policy of goal of preserving the jury's role in determining the meaning of evidence and deciding matters of credibility. The substantive law does not *require* the jury to decide whether a given witness was lying or telling the truth at trial. The jury may, of course, make that determination in their deliberations, and evidence offered on that point may satisfy basic relevancy, but the substantive law does not demand an answer to that question.

Using *Semrau* as an example, the opinion Dr. Laken was prepared to give was that Dr. Semrau "believes that he is telling the truth" ²⁸⁴ His opinion was limited to an "overall" impression of truthfulness, and he specifically denied being able to tell whether Dr. Semrau answered any of the SIQs truthfully. ²⁸⁵ Accepting the fact that credibility is "of consequence" within the meaning of Rule 401, Dr. Laken's opinion, based upon his fMRI scan of Dr. Semrau, had some tendency to make it more likely that Dr. Semrau's in-court testimony, if consistent with his scanner statements, was truthful. Arguably, one who is "overall truthful" during an fMRI scan or who subjectively believes he is telling the truth is more likely to be telling the truth when testifying consistent with the scan statements than one who was determined to be deceptive during a scan or one who does not believe he is telling the truth. The scan results have some "tendency" to support the credibility of Dr. Semrau because the jury could infer his testimony at trial was truthful based upon the opinion of Dr. Laken.

The substantive law, however, did not require the jury to decide whether Dr. Semrau was telling the truth or lying at trial. Dr. Semrau's trial testimony of his intent was probative of his intent at the time of the charged offenses and, if believed by the jury, would have exonerated him of those charges. But whether he was lying on the witness stand was not an element the government

²⁸⁴ Testimony of Steven Laken, Transcript of Proceedings, May 13, 2010, Vol. I. at 99, *United States v. Semrau*, No. 07CR10074-1JPM (W.D. Tenn., June 1, 2010).

²⁸⁵ *Id.* at 137-41.

was required to prove in order to convict. In fact, the law did not even require him to place his credibility in issue at all.²⁸⁶ He could have exercised his right not to testify. The trial strategy to take the stand and place his credibility before the jury was sufficient to make his credibility relevant in the general sense, but it did not create a situation where the jury was required to decide whether he was lying or telling the truth in order to decide the case. One might infer from the jury's ultimate verdict whether they credited his testimony, but the substantive law did not require the jury to label him either a liar or a truth-teller in order to decide the case. Using Professor Faigman's paradigm, one could say the "legal fit" required by the helpfulness standard was not met.

In addition to the disconnect between fMRI-based opinion on witness truthfulness and what the jury must actually decide, there are broader policy reasons that counsel against professionalizing the task of determining witness truthfulness. The "help the jury" standard imposed by Rule 702 is broad enough and flexible enough to determine whether admitting this sort of testimony will help a specific jury in a specific case and whether it will help the jury in the systemic sense.

Federal court decisions both before and after the adoption of the Federal Rules of Evidence have generally found expert opinion on whether a witness is telling the truth unhelpful because credibility decisions are committed exclusively to the jury and the opinion of an expert merely tells the jury whom to believe.²⁸⁷ Some

²⁸⁶ See *supra* note 201 and accompanying text.

²⁸⁷ See, e.g., *United States v. Hill*, 749 F.3d 1250, 1258 (10th Cir. 2014) (holding that there was plain error to admit expert opinion on witness credibility because it "(1) 'usurps a critical function of the jury'; (2) 'is not helpful to the jury, which can make its own determination of credibility'; and (3) when provided by 'impressively qualified experts on the credibility of other witnesses is prejudicial and unduly influences the jury'") (quoting *United States v. Toledo*, 985 F.2d 1462, 1470 (10th Cir. 1993)); *Marvel Characters, Inc. v. Kirby*, 726 F.3d 119, 135–36 (2d Cir. 2013) (excluding expert historians who interviewed associates of the parties and constructed a picture of the relationship between the parties, including credibility); *United States v. Lespier*, 725 F.3d 437, 448–49 (4th Cir. 2013) (excluding expert testimony that sleep deprivation

caused the defendant to give inconsistent statements; jurors could understand point without aid of expert); *United States v. Allen*, 716 F.3d 98, 105–06 (4th Cir. 2013) (finding expert testimony offered solely for the purpose of undermining the credibility of the codefendant witness is “not the function of an expert”); *Cameron v. City of New York*, 598 F.3d 50, 61 (2d Cir. 2010) (“First, ‘[a]s a matter of law, the credibility of witnesses is exclusively for the determination by the jury, and witnesses may not opine as to the credibility of the testimony of other witnesses at the trial.’”) (quoting *United States v. Forrester*, 60 F.3d 52, 63 (2d Cir. 1995)); *Nimely v. City of New York*, 414, F.3d 381, 397–98 (2d Cir. 2005) (“It is a well-recognized principle of our trial system that ‘determining the weight and credibility of [a witness’s] testimony . . . belongs to the jury, who are presumed to be fitted for it by their natural intelligence and their practical knowledge of men and the ways of men’”) (quoting *Aetna Life Ins. Co. v. Ward*, 140 U.S. 76, 88 (1891)); *Wilson v. Muckala*, 303 F.3d 1207, 1218 (10th Cir. 2002) (holding that it was not error to exclude expert’s opinion on plaintiff’s credibility); *United States v. Mathis*, 264 F.3d 321, 340 (3d Cir. 2001) (admitting expert testimony when the expert “made quite clear that he did not intend to tell the jury whether . . . [the witness] was lying or telling the truth”); *Goodwin v. MTD Prod., Inc.* 232 F.3d 600, 609 (7th Cir. 2000) (“[A]n expert cannot testify as to credibility issues; [r]ather, credibility questions are within the province of the trier of fact”); *United States v. Charley*, 189 F.3d 1251, 1267 (10th Cir. 1999) (“In general, expert testimony which does nothing but vouch for the credibility of another witness encroaches upon the jury’s vital and exclusive function to make credibility determinations, and therefore does not ‘assist the trier of fact as required by Rule 702.’”); *Greenwell v. Boatwright*, 184 F.3d 492, 496 (6th Cir. 1999) (finding error, but harmless, for expert to comment on the credibility of eyewitness’s account of accident); *United States v. Sanchez-Lima*, 161 F.3d 545, 548 (9th Cir. 1998) (“Testimony regarding a witness’ credibility is prohibited unless it is admissible as character evidence.”); *United States v. Call*, 129 F.2d 1402, 1405–06 (10th Cir. 1997) (affirming exclusion of polygraph evidence to corroborate defendant’s testimony under Rule 403 because “it usurps a critical function of the jury and because it is not helpful to the jury, which is capable of making its own determination regarding credibility”); *United States v. Kime*, 99 F.3d 870, 884 (8th Cir. 1996) (“It is the exclusive province of the jury to determine the believability of a witness. . . . An expert is not permitted to offer an opinion as to the believability or truthfulness of a victim’s story.”) (quoting *Bachman v. Leapley*, 953 F.2d 440, 441 (8th Cir. 1992); *United States v. Beasley*, 72 F.3d 1518, 1528 (11th Cir. 1996) (“Expert medical testimony concerning the truthfulness or credibility of a witness is generally inadmissible because it invades the jury’s province to make credibility determinations.”); *Hoult v. Hoult*, 57 F.3d 1, 7 (1st Cir. 1995) (“It is the function of the jury alone to evaluate the credibility of a witness When an expert

commentators, however, have argued that the adoption of the

witness testifies with respect to the credibility of a victim/witness there is a real danger that jurors will lend too much credence to the expert's evaluation of the victim's credibility, at the expense of their own independent judgment of credibility."); *Westcott v. Crinklaw*, 68 F.3d 1073, 1076 (8th Cir. 1995) ("Nor may an expert pass judgment on a witness' truthfulness in the guise of a professional opinion."); *United States v. Whitted*, 11 F.3d 782, 785-86 (8th Cir. 1993) ("A doctor also cannot pass judgment on the alleged victim's truthfulness in the guise of a medical opinion, because it is the jury's function to decide credibility."); *United States v. Benson*, 941 F.2d 598, 604 (7th Cir. 1991) ("Credibility is not a proper subject for expert testimony; the jury does not need an expert to tell it whom to believe, and the expert's 'stamp of approval' on a particular witness may unduly influence the jury."), *modified on reh'g, on other grounds*, 957 F.2d 301 (7th Cir. 1992); *United States v. Azure*, 801 F.2d 336, 339-41 (8th Cir. 1986) (finding error to admit pediatrician's opinion that victim of child sexual abuse was telling the truth when she identified defendant as her abuser), *overruled in part on other grounds by* *United States v. Morales*, 108 F.3d 1031 (8th Cir. 1997); *United States v. Price*, 722 F.2d 88, 90 (5th Cir. 1983) ("But in some instances, the introduction of . . . testimony bolstering the credibility of witnesses may cause harm that goes beyond the mere wasting of time. When bolstering testimony suggests to the jury that it may shift to a witness the responsibility for determining the truth of evidence, its admission may constitute reversible error."); *United States v. Awkard*, 597 F.2d 667, 671 (9th Cir. 1979) ("Under the Federal Rules, opinion testimony on credibility is limited to character; all other opinions on credibility are for the jurors themselves to form."); *United States v. Libby*, 461 F. Supp. 3, 7 (D.D.C. 2006) ("Expert testimony will . . . be precluded if it would usurp the jury's role as the final arbiter of the facts, such as testimony on witness credibility and state of mind."); *see also* STEPHEN A. SALTZBURG, MICHAEL M. MARTIN & DANIEL J. CAPRA, 3 FEDERAL RULES OF EVIDENCE MANUAL § 702.02[15] (10th ed. 2011) ("[I]f the expert does intrude on areas left for the jury—such as the credibility of a witness—the trial judge should exclude the testimony as unhelpful."). *But see* *United States v. Williams*, 95 F.3d 723, 723 (8th Cir. 1996) (excluding under *Daubert* defense evidence that government's key witness failed a polygraph administered by the FBI without mention of general prohibition of expert opinion testimony on witness truthfulness); *United States v. Piccinonna*, 885 F.2d 1529, 1535-37 (11th Cir. 1989) (en banc) (reversing *per se* ban on polygraph evidence and conditioning admissibility of polygraph examiner's opinion on (1) parties stipulate to the admission; and (2) whether the opinion satisfies the rules governing impeachment or corroboration of a witness's testimony); *see also* *United States v. Cordoba*, 104 F.3d 225 (9th Cir. 1997) (holding *Daubert* effectively overruled *per se* bans on polygraph testimony and conditioned admissibility on Rules 702 and 403).

Federal Rules of Evidence paved the way for admission of opinions on truthfulness if they meet Rule 401 relevancy and Rule 702 reliability standards irrespective of the tradition of leaving credibility judgments to the jury.²⁸⁸ Generally, they argue that Rule 702's regulation of expert testimony replaced the traditional

²⁸⁸ See, e.g., Arthur Best & Jennifer Middleton, *Winking at the Jury: "Implicit Vouching" Versus the Limits on Opinions About Credibility*, 55 ARIZ. L. REV. 265 (2013) (arguing that allowing explicit testimony on credibility of child abuse victim is preferable to current practice of implicitly vouching for credibility by describing attributes of victim of abuse); Mark Pettit, Jr., *FMRI and BF Meet FRE: Brain Imaging and the Federal Rules of Evidence*, 33 AM. J. L. & MED. 319, 334 (2007) ("Courts with no doubts about reliability would accept the science and find ways to deal with the problems of implementation that such acceptance would present."); Anne Bowen Poulin, *Credibility: A Fair Subject for Expert Testimony*, 59 FLA. L. REV. 991, 1004-05 (2007) ("[R]ather than invoking the maxim that the determination of credibility is the jury's special province, courts should welcome expert testimony that helps the jury determine whether a particular witness is being truthful and whether a particular account of the facts is accurate."); Keckler, *supra* note 32, at 543 ("The evidence presented by the expert is about the scan, or perhaps at most the statement, and not directly about the witness. Consequently, evidence of this sort allows a jury to make its own assessment of the witness."); Ric Simmons, *Conquering the Province of the Jury: Expert Testimony and the Professionalization of Fact-Finding*, 74 U. CIN. L. REV. 1013, 1066 (2006) ("Essentially, if we can determine that there are experts that can provide reliable and useful information about credibility (and the evidence suggests that we are at or very near that point), why would we want a lay jury to make these most critical decisions without any guidance? It is now past time to jettison this tradition altogether and give the juries all the available tools to carry out the immensely difficult task that we assign to them."); Edward J. Imwinkelried and James R. McCall, *Issues Once Moot: The Other Evidentiary Objections to the Admission of Exculpatory Polygraph Examinations*, 32 WAKE FOREST L. REV. 1045, 1080 (1997) ("[T]estimony about an exculpatory polygraph examination is no more and no less than scientific evidence of the accused's subjective consciousness of innocence."); James R. McCall, *Misconceptions and Reevaluation-Polygraph Admissibility After Rock and Daubert*, 1996 U. ILL. L. REV. 363, 422 (predicting increased admissibility of polygraph evidence of witness truthfulness after *Daubert*); Margaret A. Berger, *United States v. Scop: The Common-Law Approach to an Expert's Opinion About a Witness's Credibility Still Does Not Work*, 55 BROOK. L. REV. 559, 586 (1989) ("Opinion testimony on credibility offered on a theory other than to prove character should . . . be admissible provided it satisfies the relevancy test of Rule 401.").

practice of assigning credibility matters exclusively to the jury. Empirical studies, they posit, support the fact that juries are not particularly good at making credibility judgments, and since we admit a host of other forensic evidence of uncertain reliability, there is no sound policy reason why an exception should exist when the subject matter is witness truthfulness. The historical notion that expert testimony on witness truthfulness “invades the province of the jury,” they argue, should be abandoned in favor of application of the rules governing the admissibility of all expert testimony.²⁸⁹

But is there something unique about witness truthfulness that supports the argument that the jury is the lie detector and expert opinions on witness truthfulness are not helpful to the jury?²⁹⁰ Professor Ric Simmons argues that courts should reject the traditional notion that expert opinion on truthfulness is not helpful to the jury in favor of the relevant and reliable standard of Rule 702.²⁹¹ In urging the admissibility of polygraph evidence, he argues that credibility issues are relevant²⁹² in jury trials and that

²⁸⁹ See, e.g., Simmons, *supra* note 288, at 1015 (“[T]he province-of-the-jury prohibition is poorly defined, lacks a legitimate doctrinal basis, and should be abolished in its entirety, so that every piece of expert testimony is evaluated under the same standards and admitted or excluded on the reliability standards of *Daubert*.”); Bellin, *supra* note 162, at 718–21 (commenting that the argument that lie detection technology invades the province of the jury is “unlikely to serve as [a] significant obstacle” to admitting expert opinion on witness truthfulness based on reliable technology).

²⁹⁰ For a detailed historical account of the legal system’s delegation to the jury issues of witness credibility, especially the problem of resolving conflicting factual accounts presented by sworn testimony, see Fisher, *supra* note 69, at 577.

²⁹¹ Simmons, *supra* note 288, at 1028–46.

²⁹² Professor Simmons views the jury assistance prong of Rule 702 coextensive with Rule 401 and does not appear to accept the view that Rule 702 imposes a more exacting standard on expert testimony. *Id.* at 1050. *But see* *Daubert v. Merrell Dow Pharm., Inc.*, 43 F.3d 1311, 1321 n.17 (9th Cir. 1995) (“The Supreme Court recognized that the fit requirement goes primarily to relevance, but it obviously did not intend the second prong of Rule 702 to be merely a reiteration of the general relevancy requirement of Rule 402.”); *In re*

polygraph evidence has reached a reliability threshold on par with other forensic evidence, so unless there is something unique or different about the credibility of polygraph evidence, it should also be admissible.²⁹³

Whether a given witness is lying as he sits before the jury and recounts his perception of the historical event is a question potentially present in any contested jury trial. Gone are the days where the law avoided such direct conflicts between witnesses, each sworn to tell the truth, the whole truth, and nothing but the truth.²⁹⁴ But it cannot be denied that resolving such conflicting testimony is, unquestionably, a core function of the jury. Professor George Fisher ably demonstrates that over the centuries the law inexorably moved toward placing that critical determination solely in the hands of the jury, primarily as a way to support the legitimacy of the system.²⁹⁵ “The jury’s role as the system’s lie

Paoli RR Yard PCB Litigation, 35 F.3d 717, 745 (3d Cir. 1994) (explaining that the Rule 702 “standard is higher than bare relevance”).

²⁹³ Professor Simmons does not consider the polygraph a “lie detector” in a technical sense. He explains that the interrogation techniques most commonly employed by polygraph examiners, the “control question” method and the “guilty knowledge” test, reveal the subject’s guilty conscience or his knowledge of incriminating facts, respectively. Accordingly, he argues that polygraph examiners are really offering opinions on the subject’s state of mind during the interview and not whether they were lying or telling the truth during the polygraph examination. Simmons, *supra* note 288, at 1038–39 (“In this sense, polygraph examiners are not ‘credibility experts’ but rather ‘state of mind experts,’ because they claim to be able to interpret physiological reactions to certain stimuli in order to reach conclusions about the mental state or knowledge possessed by the subject.”).

²⁹⁴ See Fisher, *supra* note 69, at 600.

²⁹⁵ *Id.* at 705 (“The jury, in contrast [to the oath requirement and competency limitations], promised a remarkably reliable source of systemic legitimacy. Its usually private and inarticulate decision making protected it from the sort of embarrassing public failures that so regularly threatened the oath. There never has been a mechanism by which the defendant or anyone outside the system could command the jury to reveal its decision making processes. The jury’s secrecy is an aid to legitimacy, for the privacy of the jury box shrouds the shortcomings of its methods.”).

detector,” he argues, “has only grown and has never, for a sustained time, diminished.”²⁹⁶

Credibility, especially witness truthfulness, does occupy a unique place in the role and function of the jury. It is a serious thing to label a person a liar. The history of the jury system and the elaborate rules employed over the centuries to avoid conflicting accounts from sworn witnesses is evidence that the system itself was concerned, perhaps overly so, with the problem of competing oaths and witness truthfulness.²⁹⁷ If, as history demonstrates, the legitimacy of the jury system and the public’s confidence in its verdicts depend upon the secrecy of the collective deliberations of the members of the jury, the professionalization of witness truthfulness offers the jury a tempting way out of struggling through the difficult task of weighing all the evidence, considering all the facts, applying reason and common sense to the various accounts, reconciling discrepancies, and, yes, even deciding whether a given witness lied on the stand. Instead, they can defer to the “expert” and be done with it. While their deliberations will remain secret and their verdicts general, we might reasonably suspect they did not fulfill their role as a “valuable safeguard to liberty [and] . . . the very palladium of free government.”²⁹⁸ If juries are tempted to rely upon professional witnesses and colorful images produced by powerful computers and modern machines, they probably will.²⁹⁹ If a group of American citizens sitting on a

²⁹⁶ *Id.* at 703.

²⁹⁷ *Id.*

²⁹⁸ THE FEDERALIST NO. 83, at 543 (Alexander Hamilton) (Modern Library College ed., 1964).

²⁹⁹ See McCabe et al., *supra* note 84, at 572–75 (finding fMRI lie detection evidence influenced mock jurors more than polygraph or thermal imaging evidence of deception, but was no greater than the control group when its validity was questioned); see also McCabe & Castel, *supra* note 84, at 350 (finding neuroscientific explanations more persuasive when accompanied by brain images). But see N. J. Schweitzer et al., *Neuroimages as Evidence in a Mens Rea Defense: No Impact*, PSYCHOL. PUB. POL’Y. & L. 357 (2011) (finding neuroimages had no enhanced influence on mock jurors); Roskies et al., *supra* note 84 (reviewing studies and concluding that neuroimages did not unduly affect mock juror decisions).

jury debating the fate of a fellow citizen is “the very essence of our democracy,”³⁰⁰ injecting colorful images of a brain “lighting up” while purportedly processing a lie, may diminish the jury’s essential role in our system by fostering the notion that machines, not people, are actually determining the outcome of trials.

The move toward professionalizing witness truthfulness not only diminishes the jury’s traditional role as the fact-finder, but it exposes the hidden and controversial role of the jury as a political actor and the issue of jury nullification of the law. Professor Julie Seaman argues that as machines determine the truth, juries will be left with the notion that their only choices are to “rubber-stamp the prosecution’s demand for conviction or . . . exercise their non-fact-finding functions” specifically, by a verdict nullifying the applicable law.³⁰¹ This would raise the issue of “whether the jury is merely a fact-finding machine that should be replaced by a better fact-finding machine, or whether it has a political, institutional role worth preserving apart from its ability to judge the credibility of witnesses and the historical facts.”³⁰² Professor Seaman concludes:

[W]ere an accurate lie detector developed, the jury’s unique role in determining witness credibility would be called into question. At that moment, in many cases, the criminal jury would exist either to rubber-stamp the prosecution’s version of the historical facts, or instead to serve distinct, non-fact-finding functions in addition to determining historical fact. The former vision of the jury would relegate it to an increasingly trivial role, one at odds with the history, precedent, and purposes of the right to jury trial embodied in the Constitution. The latter vision, in contrast, would allow the jury knowledge of its

³⁰⁰ Charles J. Ogletree, Jr., *Foreword* to ANDREW GUTHRIE FERGUSON, *WHY JURY DUTY MATTERS: A CITIZEN’S GUIDE TO CONSTITUTIONAL ACTION*, at xvii (2013).

³⁰¹ Julie A. Seaman, *Black Boxes*, 58 EMORY L.J. 427, 486 (2008); *see also* Arie M. Rubenstein, *Verdicts of Conscience: Nullification and the Modern Jury Trial*, 106 COLUM. L. REV. 959 (2006) (discussing the history and current role of jury nullification in American jurisprudence); Daryl K. Brown, *Jury Nullification Within the Rule of Law*, 81 MINN. L. REV. 1149 (1997); H.B. 1452, 2013 Leg., 163d Sess. (N.H. 2013) (pending) (requiring the court to give an instruction to the jury regarding jury nullification or declare a mistrial if the instruction is not given to the jury).

³⁰² Seaman, *supra* note 301, at 486.

legislative function, even while risking that it might exercise it in ways that courts or the public find illegitimate.³⁰³

Despite the promise, and desirability, of more accurate fact-finding, expert opinion testimony on truth-telling is a radical departure from the established American practice. The benefit of more accurate fact-finding must be weighed against the risk of delegitimizing the jury as the bulwark between the citizen and the power of the state and, in civil cases, the unbiased umpire in private disputes.

In addition to delegitimizing the core function of the jury, when machines determine truth it risks dehumanizing the participants of the trial. Witnesses and parties become objects upon which to apply the mysteries of modern science. Modern science, of course, often informs juries of the nature of a substance, the likelihood of a defendant's presence or participation in the crime based upon DNA analysis, or the cause of death or disease and in doing so may create doubts about a witness's story. But it creates those doubts by establishing other relevant facts, not by reaching into the mind of the witness to determine whether the witness is lying or telling the truth.

In *State v. Lyon*,³⁰⁴ a case where the parties stipulated to the admissibility of polygraph results, the Oregon Supreme Court ruled that polygraph evidence was inadmissible because the stipulation did little to enhance the reliability of the polygraph and that the jury may be unduly persuaded by the scientific evidence.³⁰⁵ In a separate opinion, Justice Linde concurred with the court's reasoning but raised the more profound question of the system's unease with machines detecting lies and verifying truth:

The polygraph does not independently establish any past, present, or future fact. It purports neither to replace nor to supplement the assertions of the tested person with other evidence on the matter in question. The polygraph is indifferent to what the assertions are about and whether they are factually correct. As its popular name suggests, the lie detector only purports to detect whether a person is uttering a lie.

³⁰³ *Id.* at 488.

³⁰⁴ 744 P.2d 231 (Ore. 1987).

³⁰⁵ *Id.* at 235-36.

....

The institution of the trial, above all, assumes the importance of human judgment in assessing the statements of disputing parties and other witnesses. The cherished courtroom drama of confrontation, oral testimony and cross-examination is designed to let a jury pass judgment on their truthfulness and on the accuracy of their testimony. The central myth of the trial is that truth can be discovered in no better way, though it has long been argued that the drama really serves symbolic values more important than reliable factfinding. One of these implicit values surely is to see that parties and the witnesses are treated as persons to be believed or disbelieved by their peers rather than as electrochemical systems to be certified as truthful or mendacious by a machine.³⁰⁶

Whether one thinks Justice Linde has carried the values argument too far to the detriment of accurate fact-finding,³⁰⁷ his view does require reflection upon whether professionalizing witness truthfulness helps or hinders the larger role of the jury in our society and in our system of justice. While perhaps not the determining factor on whether expert opinion on witness truthfulness helps the jury, it is a factor.

Credibility issues, whether they concern poor memory, poor perception, poor character for truthfulness, or consciously lying at trial, are collateral to the central question in the case: guilt or innocence, liable or not liable.³⁰⁸ If expert testimony on whether a witness told the expert a lie or the truth while in the expert's office is admissible because it meets the any tendency standard of Rule 401 and is as reliable as other questionable forensic evidence routinely admitted,³⁰⁹ conscientious trial lawyers will present that

³⁰⁶ *Id.* at 236–37 (Linde, J., concurring) (citation omitted).

³⁰⁷ See, e.g., James. R. McCall, *The Personhood Argument Against Polygraph Evidence, Or "Even if the Polygraph Really Works, Will Courts Admit the Results?"*, 49 HASTINGS L.J. 925, 941–43 (1998) (acknowledging the importance of the issue but arguing that accurate fact-finding is the more important value).

³⁰⁸ See *supra* note 201.

³⁰⁹ A 2009 report by the National Academy of Sciences found serious deficiencies in the reliability of many forms of forensic science routinely admitted in American courtrooms. Two major concerns were "the extent to which particular areas of forensic science are based upon reliable scientific methodology . . ." and "the extent to which . . . human interpretation [of test results] could be tainted by error, the threat of bias, or the absence of sound

evidence in support of every significant witness in the case. Failure to do so may be seen as falling beneath the standard expected of a reasonably competent trial lawyer. Trials will be more expensive, take more time, and demand more resources than they do now. Of course, the experts involved will make more money because their services will be more in demand. That does not mean, however, that more justice will be done or the system will be better served.³¹⁰

While the commentators may have a point that the Federal Rules did not explicitly codify the common law “invade the province of the jury” prohibition on expert opinion on witness truthfulness, the “help the jury” requirement in Rule 702 is both broad and specific enough to justify consideration of the impact of such evidence on the system of justice, generally, and the conduct of a given trial specifically.³¹¹

Admittedly, the above concerns are value judgments rather than objective factors established by empirical data. Some may argue they are throw backs to an old way of thinking about human thinking. But they are values deeply rooted in our system of dispute resolution, both criminal and civil, and should not be lightly abandoned in a quest for a more accurate lie detector.

operational procedures and robust performance standards” within the discipline. COMM. ON IDENTIFYING THE NEEDS OF THE FORENSIC CMTY. ET AL., STRENGTHENING FORENSIC SCIENCE IN THE UNITED STATES: A PATH FORWARD 9 (2009).

³¹⁰ See D. Michael Risinger, *Navigating Expert Reliability: Are Criminal Standards of Certainty Being Left on the Dock?*, 64 ALB. L. REV. 99, 131 (2000) (commenting that admitting polygraph evidence “is likely to lead to profound alterations in the entire litigation system, alterations which cannot be predicted and which may not be desirable once they are played out,” including diminishing the jury’s core function of determining witness credibility).

³¹¹ CHRISTOPHER B. MUELLER, LAIRD C. KIRKPATRICK & CHARLES H. ROSE III, EVIDENCE: PRACTICE UNDER THE RULES § 7.6 (4th ed. 2012) (“[W]here the issue and subject are ones that lay jurors can appreciate and evaluate by applying common knowledge and good sense, admitting expert testimony seems the wrong thing to do and may warrant reversal if it is likely to dissuade the jury from exercising independent judgment or to take over the jury’s traditional function of appraising the credibility of witnesses.”).

The arguments of the commentators that expert opinion on truthfulness should be admitted have not persuaded the courts.³¹² The long line of authority excluding expert opinion on witness truthfulness is a significant obstacle for proponents of fMRI-based lie detection. The underlying reliability of the technology does not matter if the opinion based on the technology is otherwise not something that will help the jury in its core function, or worse yet, actually undermine one of the policy goals behind Rule 702 itself. To hold otherwise disregards the “fit” requirement of Rule 702, diminishes the jury’s core-function of fact-finding, distorts the jury system by devoting disproportionate time and resources to the collateral matter of credibility, downplays the jury’s importance in our system of justice, and runs the risk of dehumanizing the participants.

ii. *Empirical Fit*

In addition to the issues presented by the “legal fit” prong of the helpfulness standard, the “empirical fit” component presents even more substantial problems for fMRI-based expert opinion on

³¹² See *supra* note 287 (listing cases decided after the adoption of the Federal Rules of Evidence excluding expert opinion testimony on whether a witness testified truthfully). See also Steven I. Friedland, *On Common Sense and the Evaluation of Witness Credibility*, 40 CASE W. RES. L. REV. 165, 223 (1990) (concluding that the traditional approach of excluding expert opinion on witness credibility has merit except in some narrowly defined circumstances and proposing a new rule of evidence to address those circumstances); DAVID L. FAIGMAN ET AL., 2 MODERN SCIENTIFIC EVIDENCE: THE LAW AND SCIENCE OF EXPERT TESTIMONY § 17:9 (2012–2013 ed. 2012) (“Courts nearly uniformly prohibit experts (or any witness) from offering an opinion regarding the trustworthiness of a witness’ specific allegations.”); DAVID H. KAYE ET AL., THE NEW WIGMORE: A TREATISE ON EVIDENCE: EXPERT EVIDENCE § 2.4 (2014) available at Westlaw WIGVEVEE (commenting that predictions in earlier versions of the WIGMORE treatise, as well as WEINSTEIN’S EVIDENCE treatise, that expert testimony on witness veracity would become admissible had failed to materialize and noting that, “[t]he traditional rule—that expert testimony on whether a witness is telling the truth or has the tendency to do so is not permitted—remains the law in most jurisdictions”); SALTZBURG, MARTIN & CAPRA, *supra* note 287, at §§ 702.02(15), 702.03(24)(b) (collecting cases and noting that expert testimony on witness credibility should be excluded as not helpful to the jury).

truthfulness. Professors Faigman, Mohahan, and Slobogin phrase the question of empirical fit as “whether particular scientific results have external validity with respect to the circumstances the law makes relevant.”³¹³ The external validity of a scientific study is the degree to which the findings can be applied to groups or individuals who were not participants in the study itself.³¹⁴

The “empirical fit” requirement resembles the analysis of probative value under Rule 403.³¹⁵ The better the fit between the facts of the case and the proffered opinion, the greater the probative value of the opinion and, as a result, the more it helps the trier of fact. Including this consideration at this point in the admissibility determination, however, reveals that the helpfulness standard of Rule 702 requires more than the low bar of general relevancy found in Rule 401. Unlike Rule 401, which applies an “any tendency” standard, and Rule 403, which includes consideration of counterweights to probative value, the fit requirement of Rule 702 focuses on whether and how much the proffered testimony will assist the jury in its fact-finding task. The rule does not, however, establish a threshold that evidence must clear in order to be found “helpful.” Rather, the assessment is left to the discretion of the trial judge.

Dr. Laken’s expert opinion was offered in an effort to convince the jury that Dr. Semrau was telling the truth when he testified he did not intend to defraud years earlier when he submitted his claims for reimbursement.³¹⁶ Dr. Laken, however,

³¹³ Faigman, Mohahan & Slobogin, *supra* note 279, at 25.

³¹⁴ See *infra* notes 477–83 and accompanying text for a discussion of external validity in the context of fMRI lie detection studies.

³¹⁵ “The court may exclude relevant evidence if its probative value is substantially outweighed by a danger of one or more of the following: unfair prejudice, confusing the issues, misleading the jury, undue delay, wasting time, or needlessly presenting cumulative evidence.” FED. R. EVID. 403. Compare Calvin William Sharpe, *Reliability Under Rule 702: A Specialized Application of 403*, 34 SETON HALL L. REV. 289 (2004) with Dale A. Nance, *Reliability and the Admissibility of Experts*, 34 SETON HALL L. REV. 191 (2003).

³¹⁶ Dr. Laken’s opinion was never offered at trial because it was excluded after a pre-trial hearing. Had it passed the admissibility standards of Rules 702

had no opinion on that point and admitted that he could not reach an opinion on that issue. He could only say his fMRI scan indicated Dr. Semrau subjectively believed he was telling the truth when he denied having an intent to defraud. The jury, however, had to decide whether Dr. Semrau had the intent to defraud in each of the sixty counts of fraud for which he stood accused. The issue for the jury was not whether Dr. Semrau was “overall” truthful, but whether he had the intent to defraud for *each* claim specified in the indictment.³¹⁷ There was a gap between the issue the jury had to decide and the opinion Dr. Laken was prepared to give. Dr. Laken could not give an opinion on whether the in-court testimony was truthful; he could only speak to his scan results. While it would not be illogical for the jury to infer truthfulness at trial from the scan results, there is still an analytical gap between Dr. Laken’s interpretation of the scan and what the jury must determine. The inferences from Dr. Laken’s opinion to actual truthfulness of trial testimony denying intent to defraud may satisfy the “any tendency” standard of Rule 401, but the “help the jury” standard of Rule 702 requires not just a bare logical connection between the opinion and the fact to be determined; it requires the court to assess the strength of that connection.³¹⁸

and 403, the rules governing impeachment and rehabilitation of witnesses would have required Dr. Semrau to testify at trial and suffer impeachment that contained an express or implied charge that his in-court testimony was deliberately false before the opinion testimony could be presented. *See supra* Part IV. Rules of Evidence: Attacking and Supporting Credibility. The Sixth Circuit’s opinion notes that Dr. Semrau testified in his own defense, but does not discuss any impeachment. Dr. Semrau argued on appeal that Dr. Laken’s opinion should have been admitted because it “‘does not confuse the issues’ but rather ‘corroborates his testimony.’” *United States v. Semrau*, 693 F.3d 510, 523 (6th Cir. 2012).

³¹⁷ Jury Instructions, *United States v. Semrau*, No. 2:07–CR–10074–JPM, 2011 WL 9258, at *22, *25 (W.D. Tenn. Jan. 3, 2010) (copy on file with the author).

³¹⁸ *Daubert v. Merrell Dow Pharm., Inc.*, 509 U.S. 579, 591–92 (1993) (holding that expert opinion must be “sufficiently tied to the facts” to help the jury; “Rule 702’s ‘helpfulness’ standard requires a valid scientific connection to the pertinent inquiry as a precondition to admissibility.”).

One might argue that Dr. Laken's opinion as to Dr. Semrau's subjective belief in his own truthfulness, as evidenced by the BOLD response to the SIQs during the scan, is circumstantial evidence of his actual innocent state of mind at the time of each of the alleged offenses and is, therefore, of some utility to the jury in deciding the underlying facts of the case. But the same can be said of the not guilty plea itself and the presumption of innocence that cloaks a criminal defendant. The fact that a defendant pleads not guilty and opts for a trial is, arguably, some evidence that he subjectively believes his own defense. Furthermore, as a matter of common sense it would seem that one who takes the witness stand, recites an oath or affirmation to tell the truth, and then recounts his version of the historical events usually believes he is telling the truth. Expert opinion of a subjective belief in the truth of his version of events does not add anything to what the jury already knows and presumes.³¹⁹ Of course, if evidence is introduced to cast doubt on the truthfulness of the witness's story, then counter evidence as to truthfulness would become more germane. But that evidence, too, would need to be more than the subjective belief of the witness in order to rebut evidence that the witness consciously lied during his testimony.

Whether Dr. Semrau actually did not have the intent to defraud when he submitted bills for reimbursement or whether he convinced himself of that over the years and after being confronted with criminal charges is something Dr. Laken and the neuroscience community cannot answer because they have not studied it.³²⁰ Neuroscientists have found that the brain can change, both structurally and functionally, due to learning, life experiences, and

³¹⁹ Faigman, *supra* note 83, at 93 ("As an initial matter . . . the testimony should concern matters that fall, at least somewhat, outside the ordinary understanding of the average juror.").

³²⁰ A recent study by researchers in China and the United States suggested that "prepared lies" the subject developed before undergoing scanning were more difficult to identify in the fMRI context and recommended further research. Xiaoqing Hu, Hao Chen & Genyue Fu, *A Repeated Lie Becomes Truth? The Effect of Intentional Control and Training on Deception*, 3 FRONTIERS IN PSYCHOL. 1, 506 (2012).

in recovery from injury. The brain is not a static set of stable neural pathways.³²¹ Whether one accused of a criminal offense, or a percipient witness to any historical event, can “learn” the details of his story over time so that it becomes “truth” to him is something the fMRI researchers have not studied. If, for example, Dr. Semrau convinced himself that his actions in upcoding claims for reimbursement and billing separately for AIMS tests were justified, reasonable, and appropriate, would repeating his sincere belief in his innocence during an fMRI scan produce a BOLD response consistent with truth? If fMRI researchers do not have an answer to that question then the opinion of witness truthfulness is of no help to the jury who must determine past events from in-court testimony. The “empirical fit” between Dr. Laken’s opinion and the issue to be decided was lacking.³²²

A final empirical misfit between Dr. Laken’s opinion in *Semrau* and the jury’s fact-finding task is the application of fMRI technology to Dr. Semrau, who was sixty-three years-old, and the subjects upon which the technology was tested were in the eighteen to fifty year-old age range. No one knows whether the thirteen year difference between the top end of the age range and Dr. Semrau is significant because no one has tested older subjects. Because the images from the group studies were produced by averaging the data from the entire group, it is not known where the BOLD response in the older subjects fell in an absolute sense. Furthermore, the average age of those tested was around thirty years-old — a thirty-three year difference in age between the participants in the underlying studies and Dr. Semrau.³²³ Whether the neural correlates of deception are the same in the brain of a

³²¹ Alvaro Pascual-Leone et al., *Characterizing Brain Cortical Plasticity and Network Dynamics Across the Age Span in Health and Disease with TMSS-EEG and TMS-fMRI*, 24 BRAIN TOPOGRAPHY 302 (2011); Alvaro Pascual-Leone et al., *The Plastic Human Brain Cortex*, 28 ANNUAL REV. OF NEUROSCIENCE 377 (2005).

³²² See Faigman, Mohahan & Slobogin, *supra* note 279, at 25.

³²³ Testimony of Steven Laken, Transcript of Proceedings, Vol. I at 156, Vol. III at 400, *United States v. Semrau*, No. 07CR10074-1JPM (W.D. Tenn. May 13, 2010).

thirty year-old and a sixty-three year-old is unknown because it has not been studied.³²⁴ There is considerable evidence, however, that the brain changes over time; children's and teenagers' brains are not as fully developed as an adult brain.³²⁵ Similarly, as time marches on, the brains of adults change with advancing age.³²⁶ Testimony on witness truthfulness based on fMRI must be derived from information that fits the demographic of the witness under scrutiny or it cannot help the jury in making credibility determinations. At the very least, studies must demonstrate that such disparities do not make a difference.

Accordingly, the disconnect between the opinion offered and the issues the jury had to decide in *Semrau*, as well as the divergence between the underlying scientific data upon which the offered opinion was grounded and the actual facts of the case, supports the conclusion that Dr. Laken's opinion would not have helped the jury and could have been excluded on that basis alone.³²⁷

But what if the current fMRI technology is better than leaving the jury to decide credibility in the traditional manner?³²⁸ Juries, as

³²⁴ *Id.* Vol. II at 190.

³²⁵ Barry C. Field, B. J. Casey, & Yasmin L. Hurd, *Adolescent Competence and Culpability: Implications of Neuroscience for Juvenile Justice Administration*, in A PRIMER ON CRIMINAL LAW AND NEUROSCIENCE, 7–10 (Stephen J. Morse & Adina L. Roskies eds., 2013) (discussing the differences between adult and juvenile brain development, and the implication of these differences in the juvenile justice system).

³²⁶ See generally Elizabeth R. Sowell, Paul M. Thompson & Arthur W. Toga, *Mapping Changes in the Human Cortex Throughout the Span of Life*, 10 NEUROSCIENTIST 372 (2004) (summarizing the morphological changes of the human brain spanning childhood through the entirety of adult life).

³²⁷ The magistrate judge in *Semrau* did consider some of these same facts in his application of the *Daubert* factors in his reliability analysis, but specifically noted that due to his conclusion that the proffered testimony was unreliable, “the court need not address the relevancy prong.” United States v. *Semrau*, No. 07–10074, 2010 WL 6845092, at *14 n.19 (W.D. Tenn. June 1, 2010).

³²⁸ Professor Frederick Schauer argues that whether science is “good” enough for the courtroom should be based on legal norms, not scientific ones. See Schauer, *supra* note 31, at 1207–09 (arguing that although fMRI results may not be good enough by science standards for reliability, they are not necessarily any

the argument goes, are so bad at determining credibility and assigning proper weight to witness testimony that any help supplied by the current state of fMRI technology should be gratefully accepted.³²⁹ But when the neuroscientists themselves admit that they cannot tell whether the subject is lying or telling the truth in response to questions about the specific allegations of the indictment, can the technology really be that helpful?

When the time gap between the events in question and the date of the fMRI scan are measured in years instead of weeks and the neuroscientists have not even asked whether that time gap might be of some significance in evaluating the neural correlates of deception, does the technology really add anything to the credibility question the jury must answer?

If neuroscientists cannot develop a study that will address the significance of the BOLD response when the subject is being questioned about a real crime that carries real consequences for the witness but instead merely assume the neural response would be the same as an undergraduate who can earn \$50 by participating in a mock crime study, can the resulting opinion really help the jury decide the important questions placed before them?³³⁰

These disconnects between fMRI deception studies and what juries have to do in a real case are not isolated or unique to the situation in *Semrau*. The inability to identify specific lies related to critical facts in a given case, the unknown impact of a large time

less reliable than other types of evidence admitted in court, and thus possibly should be admissible). While Professor Schauer makes an interesting argument, the Supreme Court held that “evidentiary reliability” is based upon “scientific validity.” *Daubert v. Merrell Dow Pharm.*, 509 U.S. 579, 590 (1993).

³²⁹ Schauer, *supra* note 31, at 1213.

³³⁰ Interestingly, neuroscientists may be scratching the surface of the answer to this very question. See Mohammad Dastjerdi, et al., *Numerical Processing in the Human Parietal Cortex During Experimental and Natural Conditions*, NATURE COMMUNICATIONS 4:2528 (2013) (finding a high degree of correlation between brain patterns detected through intracranial electrodes when subjects were engaged in specific math exercises as part of a study and the brain patterns when subjects were monitored in the non-study setting but were using math or math-related concepts in normal social interaction).

gap between the alleged offense and the fMRI scan, and the total absence of any studies involving real consequences faced by real people in a real world setting are present in every attempt to use current fMRI technology to detect deception or verify truth. These shortcomings not only do not help the jury in determining credibility, but could affirmatively mislead the jury in that important task. While the misleading aspect of these shortcomings would be properly considered in a Rule 403 analysis, Rule 702 imposes an affirmative burden on the proponent to establish that the opinion will help the jury.

To their credit, the neuroscientists readily admit these shortcomings are present. They are not trying to hide them or slip them past unsuspecting judges. In *Semrau*, Dr. Laken readily admitted to all of the aforementioned shortcomings.³³¹ But the transparency and good faith of the neuroscience community does not change the fact that there is a wide gap between what their studies purport to show and what juries have to do. The neuroscience lab is a dynamic environment where the search for “truth” is a never-ending exercise. What science finds today may be clarified, modified, or even rejected tomorrow. The courtroom, however, has an end point. A decision in this case about these facts and this defendant must be made. The finality of jury verdicts requires a perspective that is different than the scientists’ continuing search for answers. While those unresolved questions may not overly concern neuroscientists who claim fMRI is able to detect deception, the “help the jury” standard of Rule 702 makes them a very real concern to judges, lawyers, and the legal system.

4. *Sufficient Facts and Data*

Rule 702(b) asks whether the qualified expert witness has sufficient facts and data upon which to apply the principles and methods of inquiry required by her area of scientific, specialized,

³³¹ Testimony of Dr. Steven Laken, Transcript of Proceedings, May 13, 2010, Vol. I at 134, 137–38, 156–62, *United States v. Semrau*, No. 07CR10074-1JPM (W.D. Tenn.).

or technical knowledge.³³² This is the first broad area of inquiry in the reliability prong of Rule 702.

This aspect of the inquiry requires an abstract analysis of the facts and data needed by experts in the field whenever they are seeking answers to similar questions. The type of information, as well as the quantity and quality, will depend upon the issues in the case and the question the expert is attempting to answer. The field of scientific or technical knowledge may have developed a baseline set of necessary data needed by any competent expert in order to formulate an opinion using the tools of the particular discipline. For novel areas of scientific inquiry, like fMRI for lie detection, the type and quantity of information necessary may not be settled. Nevertheless, the trial judge, in performing the gatekeeping function imposed by Rule 702, must determine whether the expert has enough information to permit the principles and methods of the expert's discipline to operate.

There is a case-specific aspect of the sufficiency of the facts and data requirement, as well. Not only must the expert have access to the facts and data required by the area of scientific inquiry generally, but he must also have those that apply to the specific issue in the case at hand. In the fMRI lie detection context, the expert needs facts and data about the witness, as well as the facts and data compiled through the fMRI research dealing with truthfulness.³³³ The fMRI scan of the witness must fit within the parameters of the research upon which the hypothesis of lie detection is based.

Witness-specific data would include the details of the proposed testimony and their relationship to the factual issues to be resolved

³³² FED. R. EVID. 702(b).

³³³ The data generated by the various fMRI lie detection studies is properly considered under Rule 702(a), the sufficiency of the facts and data underlying the opinion, as well as under Rule 702(b), the reliability of the principles and methods used to form the opinion. See Brian Reese, *Using fMRI as a Lie Detector-Are We Lying to Ourselves*, 19 ALBANY L. J. SCI. & TECH. 205, 218 (2009) (observing that the underlying fMRI research implicates both FED. R. EVID. 702(a) and (b)).

by the jury. This information would then be used to develop the SIQs the witness will answer in the scanner. An insufficient factual picture may produce SIQs that are not sufficiently connected to the issues the jury must decide.

The social and medical history of the witness and his suitability for MRI scanning is also an important part of the sufficient factual basis. For example, if the witness has a history of brain abnormalities, neurological disease, or drug or alcohol addiction, he may not respond to fMRI scanning in a way that one could draw meaningful conclusions about his truthfulness.³³⁴

5. *Reliable Principles and Methods*

The second question in the reliability inquiry under Rule 702 is whether the principles and methods employed by the expert can produce a trustworthy result when applied to a sufficient body of facts and data.³³⁵ This is an abstract analysis of the scientific validity of the principles and methods relied upon by the expert.

³³⁴ See *id.* at 219–26 (identifying pathological liars, the mentally retarded, environmentally damaged, physically damaged, emotionally damaged and those with a neurodegenerative disease as inappropriate candidates for fMRI lie detection).

³³⁵ “Reliability” in the context of scientific studies is a measure of how often and well the applied procedures produce the same results. ROBERT M. LAWLESS ET AL., *EMPIRICAL METHODS IN LAW* 42 (2010). In *Daubert*, the Court specifically noted that they were not using “reliability” in its technical sense. Rather, for evidentiary purposes, “reliability” is synonymous with trustworthiness. *Daubert v. Merrell Dow Pharm.*, 509 U.S. 579, 590 n.9 (1993). (“We note that scientists typically distinguish between ‘validity’ (does the principle support what it purports to show?) and ‘reliability’ (does application of the principle produce consistent results?) . . . our reference here is to *evidentiary* reliability—that is, trustworthiness. In a case involving scientific evidence, *evidentiary reliability* will be based upon *scientific validity*.”) (citations omitted, emphasis in original). Furthermore, “reliability” for Rule 702 purposes is not the same as “the merits standard of correctness.” FED. R. EVID. 702 (2000 amendment advisory committee note), quoting *In re Paoli R.R. Yard PCB Litigation*, 35 F.3d 717, 744 (3d Cir. 1994).

This is the point in the analytical framework, suggested by the text of Rule 702, where most of the *Daubert* factors come into play.³³⁶

Publication in recognized scientific journals of the result of laboratory studies of fMRI to detect deception is some indication that the principles and methods are based on the scientific method.³³⁷ But merely counting the number of published articles is a poor proxy of reliability. The substance of those published and peer-reviewed articles is what is important in the reliability determination. Furthermore, peer-review does not necessarily mean reviewed by scientific peers and found worthy. The recent revelation that an essential finding in an oft-cited psychology paper was based on flawed mathematics is illustrative.³³⁸ The problem of flawed research getting past peer review seems particularly acute in open-access journals,³³⁹ but it is also present in the traditional print journals and in submissions from researchers at prominent institutions.³⁴⁰ The neuroscience community has not been immune

³³⁶ Others have noted that the rote application of *Daubert* factors is a poor proxy for determining the reliability and validity of fMRI-based opinion on witness truthfulness. See, e.g., 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*, 14 YALE J.L. & TECH. 1, 37–40 (2010). The *Daubert* factors, should, however, lead to a more in depth inquiry and analysis of the scientific principles and methods at issue.

³³⁷ *Daubert*, 509 U.S. at 590.

³³⁸ See Ivan Oransky, *Fredrickson-Losada "positivity ratio" paper partially withdrawn*, RETRACTION WATCH (Sep. 19, 2013, 9:30 AM), <http://retractionwatch.wordpress.com/2013/09/19/fredrickson-losada-positivity-ratio-paper-partially-withdrawn/#more-15724> (reporting that AMERICAN PSYCHOLOGIST partially withdrew a paper because the mathematical modeling upon which some of the conclusions were based was "invalid").

³³⁹ John Bohannon, *Who's Afraid of Peer Review?*, 342 SCIENCE 60 (Oct. 4, 2013) available at <http://www.sciencemag.org/content/342/6154/60.full> (reporting that author writing under false name from a non-existent institution received publication offers from 167 open access journals for a spoof article containing such obvious flaws that it should have been rejected out of hand).

³⁴⁰ See, e.g., *Archive for "Harvard" Category*, RETRACTION WATCH, <http://retractionwatch.wordpress.com/category/by-institution/harvard/> (last visited Nov. 5, 2013) (listing several instances of research published in print journals by

to the problem of questionable work getting past peer review and into publication.³⁴¹

This is not to suggest that fMRI researchers are not careful, ethical, and diligent in their research and reporting their findings. Nor does it suggest that peer review is ineffective. In fact, quite the opposite may be the case. When journals retract or clarify previously published papers it is because other scientists, or the original authors themselves, have noticed and reported flaws that undermine the conclusions. It does suggest, however, that merely counting the number of publications on a given topic is a poor proxy for scientific validity. Some analysis of the contents of those published and peer-reviewed papers is required, especially when considering novel scientific principles or the application of established principles and methods to new problems.

Many of the articles relied upon by Dr. Laken to support the application of fMRI for lie detection in individuals contained caveats and reservations about the suitability of the principles for forensic purposes.³⁴² That, however, did not seem to stop the magistrate judge from finding the *Daubert* peer review and publication query satisfied.³⁴³ Paradoxically, the magistrate judge

Harvard affiliated researchers in which retractions or other clarifications were made after peer review and publication).

³⁴¹ See *Archive for the "Neuroscience Retractions" Category*, RETRACTION WATCH, <http://retractionwatch.wordpress.com/category/by-subject/basic-life-sciences-retractions/neuroscience-retractions/> (last visited Nov. 5, 2013).

³⁴² See, e.g., Spence et al., *supra* note 44, 1760-61 (noting ecological validity, experimental design, group to individual inferences, and whether pathological liars would show similar activation patterns as study volunteers as problems that research must address); Frank A. Kozel, et al., *A Replication Study of the Neural Correlates of Deception*, 118 BEHAVIORAL NEUROSCIENCE 852, 855 (2004) (suggesting more work is needed to detect deception within individuals as opposed to group studies); Langleben et al., *supra* note 64, at 731 (calling for further refinement of test paradigm and image analysis to identify an activation pattern predictive of deception at the individual level); Kozel, et al., *supra* note 31, at 611-12 (suggesting steps and refinements necessary to detect deception in individuals).

³⁴³ *United States v. Semrau*, No. 07-10074 MI/P, 2010 WL 6845092, at *10 (W.D. Tenn. June 1, 2010). The Magistrate Judge's Report and Recommendation

found those same caveats and reservations as evidence the principles and methods relied upon by Dr. Laken had not gained sufficient acceptance in the neuroscience community to satisfy the general acceptance factor under *Daubert*.³⁴⁴

Application of the *Daubert* factors without considering the larger question of the textual framework of Rule 702 was sufficient to resolve the question before the magistrate judge in *Semrau*,³⁴⁵ and the deferential abuse of discretion scope of review on appeal affirmed the District Court's exclusion of the evidence.³⁴⁶ But the standard of Rule 702(b), that the principles and methods underlying the opinion be reliable, requires consideration of the validity of the underlying scientific studies upon which those principles are based.³⁴⁷ While the *Daubert* factors are considerations in determining whether a principle or method derived from research is sound, it is important to place those factors into the context of scientific validity based upon Rule 702(b).

Scientific research is routinely evaluated by considering its "reliability" and its "validity." Reliability is a function of reproducibility. Does the test produce the same or similar results each time it is applied?³⁴⁸ It is a measure of stability, not accuracy. Validity asks whether the study or test produces accurate and credible data from which well-reasoned conclusions can be drawn.³⁴⁹ In the context of fMRI lie detection research, the scientific validity question requires consideration of: (1) internal validity, (2) external validity, and (3) ecological validity.³⁵⁰

to exclude the fMRI-based expert testimony was adopted by the district judge and affirmed on appeal. *United States v. Semrau*, 693 F.3d 510 (6th Cir. 2012).

³⁴⁴ *Semrau*, 2010 WL 6845092 at *11–13.

³⁴⁵ *Id.*

³⁴⁶ *Semrau*, 693 F.3d at 520–23.

³⁴⁷ FED. R. EVID. 702(c).

³⁴⁸ LAWLESS ET AL., *supra* note 335, at 42.

³⁴⁹ *Id.* at 36.

³⁵⁰ See Bruce R. DeForge, *Research Design Principles*, in 3 *ENCYCLOPEDIA OF RESEARCH DESIGN* 1253, 1258 (Neil J. Salkind ed. 2010) (describing internal and external validity); Steve Fuller, *Threats to Validity*, in 3 *ENCYCLOPEDIA OF RESEARCH DESIGN* 1509, 1511 (Neil J. Salkind ed. 2010) (describing ecological

Evaluating fMRI research from the perspective of scientific reliability and validity reveals numerous shortcomings not identified by the court in *Semrau*.

a. *Replication*

A sound scientific technique or instrument should produce similar results each time it is applied. For example, if placing the same bag of sugar on the same kitchen scale consistently revealed the bag weighed five pounds, one could say the scale was a “reliable” instrument for determining weight. That is not the same as saying the scale was an *accurate* instrument for determining weight. Perhaps the scale is off by three pounds and the bag of sugar actually weighs eight pounds. One could not realize the inaccuracy of the scale, or the actual weight of the bag of sugar, unless the bag of sugar was weighed on another scale and got a different result or placed an object of a known weight on the scale and saw the weight indicated was off by three pounds. Replication of tests and experiments is an important feature in gauging the trustworthiness of the results of those tests and experiments.

fMRI lie detection studies suffer from a lack of replication within and between laboratories. One of the leading fMRI lie detection researchers, Dr. Sean A. Spence, reviewed the published literature through July 2007 and was “unable to identify a single example of this basic requirement [replication] within the extant fMRI literature.”³⁵¹

More recently, Elena Rusconi and Timothy Mitchener-Nissen observed that, “it is very unusual to see a brain imaging experiment precisely repeated within and between laboratories.”³⁵² This lack of replication may be due, in large part, to the tendency for scientific journals to publish novel studies instead of replications.³⁵³ The

validity); see also Francis X. Shen & Owen D. Jones, *Brain Scans as Evidence: Truths, Proofs, Lies, and Lessons*, 62 MERCER L. R. 861, 876–78 (2011) (discussing the impact of ecological and external validity on the admissibility of brain scans).

³⁵¹ Spence, *supra* note 46, at 24.

³⁵² Rusconi & Mitchener-Nissen, *supra* note 31, at 3.

³⁵³ *Id.*

incentive to publish pushes researchers to develop new test designs rather than seek to replicate the work of others.³⁵⁴ Spence's analysis of the literature through July 2007 bears this out: of the sixteen published peer-reviewed studies he reviewed, he found researchers used different test designs, different scanner strengths, and different response modes in various combinations that produced different areas of brain activation.³⁵⁵ As a result, no single study was ever replicated by another lab or by the original lab.³⁵⁶ All were published but replication was lacking.

A meta-analysis of twenty-three fMRI deception studies published between 2001 and 2011 revealed several brain regions, primarily in the prefrontal cortex, which were active across the studies at a rate greater than chance.³⁵⁷ Consistent with the findings of the earlier studies of replication, this analysis also noted "considerable variability from study to study, as no region was active in all (or nearly all) studies."³⁵⁸ Like Spence's 2007 study, the researchers found that differences in study design, variations among hardware and software, the number of trials each subject underwent, and the varying number of participants in the studies precluded a more precise and consistent identification of the sub regions involved in detection.³⁵⁹ While there was consistency across the studies of general brain regions of activation in deception, the meta-analysis was not able to find consistent activation in sub regions of the prefrontal cortex.³⁶⁰

³⁵⁴ *Id.*

³⁵⁵ Spence, *supra* note 46, at 14–21.

³⁵⁶ *Id.*

³⁵⁷ Farah, *supra* note 51, at 124.

³⁵⁸ *Id.*

³⁵⁹ *Id.*

³⁶⁰ *Id.* The lack of replication and reproducibility is not limited to lie detection studies. fMRI, generally, has suffered from a lack of replication. See Tancredi & Brodie, *supra* note 31, at 280–82. Differences in hardware, software, and test designs have produced varying outcomes in studies across labs and even within the same labs. *Id.* The Functional Bioinformatics Research Network ("FBIRN") established by the National Institutes of Health ("NIH") is an effort to address this problem and establish standards to bolster the reliability of fMRI studies. *Functional BIRN*, BIOMEDICAL INFORMATICS RESEARCH NETWORK, <http://www.fbirn.org>.

The testing, peer review and publication factors of the *Daubert* analysis reveal the shortcomings of the use of fMRI technology for lie detection if one considers the substance of the published literature instead of just counting the number of articles and asking whether the underlying principle can or has been tested. Only by using the *Daubert* factors as a starting point for analysis instead of the end point, will the reliability of the principles and methods become apparent.

b. *Internal Validity*

Internal validity “refers to the degree to which the research design isolates the variable of interest and permits drawing valid inferences about the relationships between variables from the resulting data.”³⁶¹ An internally valid study reduces the influence that confounding variables might have on the results.³⁶² In evaluating internal validity of the fMRI studies on lie detection, study design (sometimes referred to as methodological or construct validity) and data collection and analysis (sometimes referred to as statistical validity) are critical. If the study does not isolate the neural correlates of deception one cannot draw valid conclusions about whether the subject was lying or telling the truth during the test. If the subject does not comply precisely with the test design, the resulting data cannot lead to valid conclusions. If the assumptions used to construct the algorithms are manipulated, the conclusions produced will vary. The underlying principles and methods of fMRI lie detection must be internally valid in order to be “reliable principles and methods” under Rule 702(b).

birncommunity.org/collaborators/function-birn/ (last visited Nov. 24, 2013). The project links major research labs in a network to share experience and analysis of fMRI data with the goal of minimizing image variability and increasing reliability of fMRI studies. *Id.* The issue of lack of replication and reproducibility in empirical studies has attracted attention in other areas of scientific inquiry, as well. The Journal of Social Psychology recently published a special issue devoted to the problem. 45 SOC. PSYCH. (SPECIAL ISSUE) 137 (2014).

³⁶¹ LAWLESS, ET AL., *supra* note 335, at 36.

³⁶² *Id.*

Considering internal validity in terms of the *Daubert* factors, the existence of standards, controls, and protocols, as well as the error rate associated with a particular principle or method should lead to an examination of test design, test execution, and data analysis. Flaws in one or more of these areas raise questions as to the scientific validity and the evidentiary reliability of the opinion based upon those principles and methods.

i. *The Problem of Defining Deception*

Any scientific principle or method to detect lies and verify truth must first isolate the construct of interest (i.e., the neural correlates of deception).³⁶³ This requires the researcher to identify or define “lying,” and then design a test that will isolate the neural activity associated with that brain state and that brain state only. The corollary of this first step is to consider the question philosophers over the ages have struggled with: What is truth? Considering the following statements by prominent individuals illustrates that defining a “lie” is not as easy as it sounds:

- “I believe it is peace for our time.”³⁶⁴
- “I’m not a crook.”³⁶⁵
- “Read my lips, no new taxes.”³⁶⁶
- “I did not have sexual relations with that woman, Ms. Lewinski.”³⁶⁷

³⁶³ Rusconi & Mitchener-Nissen, *supra* note 31, at 2–3.

³⁶⁴ Neville Chamberlain, U.K. Prime Minister, Peace For Our Time Speech, Statement Made at 10 Downing Street, London, After the Munich Conference of 1938 (Sept. 30, 1938), available at http://eudocs.lib.byu.edu/index.php/Neville_Chamberlain%27s_%22Peace_For_Our_Time%22_speech.

³⁶⁵ Richard Nixon's Question and Answer Session at the Annual Convention of the Associated Press Managing Editors Association, held at the Contemporary Hotel at Walt Disney World in Orlando, Florida (Nov. 17, 1973), available at <http://abcnews.go.com/Politics/video/richard-nixon-im-crook-17736796>.

³⁶⁶ George H. W. Bush, Address Accepting the Presidential Nomination at the Republican National Convention in New Orleans (Aug. 18, 1988), available at <http://www.presidency.ucsb.edu/ws/?pid=25955>.

- “[Saddam Hussein’s regime] threatens the peace with weapons of mass murder.”³⁶⁸
- “I’ve never doped.”³⁶⁹
- “I never bet on baseball.”³⁷⁰
- “That is absolutely not true.”³⁷¹
- “What [the attack on the U.S. Consulate in Libya] began as was a spontaneous—not a premeditated—response to what had transpired in Cairo.”³⁷²
- “If you like the insurance you have, keep it. Nothing in the proposal forces anyone to change the insurance they have. Period.”³⁷³

In each instance the fact asserted by the speaker turned out to be false in some objective sense. However, several questions remain. Was the speaker lying when making the statement? Or was the speaker mistaken, naive, in self-denial, ignorant of the true state of affairs, engaged in wishful thinking, merely “spinning” the facts to suit his or her own interests, or justified in being less than forthright because of the greater good achieved if the hearer accepts the statement as true? Because “lies” are not always easy to define, and because in the forensic setting they come in

³⁶⁷ William J. Clinton, Remarks by the President at After School Program Event (Jan. 26, 1998), *available at* <http://millercenter.org/president/clinton/speeches/speech-3930>.

³⁶⁸ George W. Bush, President Bush Addresses the Nation (Mar. 19, 2003), *available at* <http://georgewbush-whitehouse.archives.gov/news/releases/2003/03/20030319-17.html>.

³⁶⁹ *Larry King Live: Lance Armstrong* (CNN television broadcast Aug. 25, 2005), *available at* <http://transcripts.cnn.com/TRANSCRIPTS/0508/25/lk1.01.html>.

³⁷⁰ WILLIAM A. COOK, PETE ROSE: BASEBALL’S ALL-TIME HIT KING, 175 (2004).

³⁷¹ *Nightline: John Edwards Admits Affair* (ABC television broadcast Aug. 8, 2008), *available at* <http://abcnews.go.com/Nightline/video/john-edwards-part-5546322> (denying the allegation that he was the father of Reille Hunter’s child).

³⁷² *This Week: Susan Rice* (ABC television broadcast Sept. 16, 2012), *available at* <http://abcnews.go.com/ThisWeek/video/susan-rice-week-17248141>.

³⁷³ *If You Like the Insurance You Have, Keep It*, WHITEHOUSE.GOV, <http://www.whitehouse.gov/health-care-meeting/proposal/titlei/keepit> (last visited Nov. 7, 2013).

numerous and sometimes subtle varieties,³⁷⁴ constructing a research design that purports to isolate “lies,” identifies their neural correlates, and then applies that research to a real-life forensic setting is no small feat, and one that to date has not been accomplished. When applied to using fMRI as a lie detector, the question becomes whether the fMRI scan was actually capturing the BOLD response associated with lying.³⁷⁵ In the vast majority of underlying studies that support the theory of fMRI-based lie detection, the subjects were instructed to lie about their involvement in the simulated theft,³⁷⁶ mock sabotage,³⁷⁷ or other staged event.³⁷⁸ The real question, then, is whether the “instructed lie” is the same as a “real lie?” If not, the underlying principle and method used to determine whether a real witness is lying, the BOLD response measured while answering the SIQs, is not a reliable principle or method.

Adlert Virj suggested that deception is a “deliberate attempt, without forewarning, to create in another a belief which the

³⁷⁴ Judge Jed Rakoff, Senior United States District Judge for the Southern District of New York, identified the problem:

The law recognizes many kinds of lies, ranging from ‘white lies’ and ‘puffing’ to affirmative misstatements, actionable half-truths, and material omissions [T]he differences are crucial in almost any case: a little white lie is altogether different, in the eyes of the law and of common sense, from an intentional scheme to defraud. Nothing in the brain-scan approach to lie detection even attempts to make such distinctions. And what might a brain scan be predicted to show in the case of a lie by omission; that is, the person whose statements are truthful as far as they go but who conceals a material fact that puts an entirely different perspective on what is being said? In my experience, these are the most common kinds of lies in court

Rakoff, *supra* note 86, at 44–45.

³⁷⁵ Shen & Jones, *supra* note 350, at 874–75; *see also* Anthony Wagner, *Can Neuroscience Identify Lies?*, in *A JUDGE’S GUIDE TO NEUROSCIENCE: A CONCISE INTRODUCTION*, 13, 13–23 (2010).

³⁷⁶ Kozel et al., *supra* note 31, at 605.

³⁷⁷ Frank. A. Kozel et al., *Functional MRI Detection of Deception After Committing a Mock Sabotage Crime*, 54 J. FORENSIC SCI. 220, 220 (2009).

³⁷⁸ Phan et al., *supra* note 62, at 165–66.

communicator considers to be untrue.”³⁷⁹ Three essential components of this definition of deception are important when developing neuroimaging studies to identify its neural correlates: (1) the communicator must deliberately intend to mislead another; (2) the deception occurs “without forewarning,” or without instruction; and (3) the “ground truth” or objective accuracy of the facts do not define the “lie.”³⁸⁰ For example, if the communicator subjectively believes that Fact A is false and deliberately attempts to create that same belief in the mind of his listener, he has engaged in deceptive behavior even if Fact A is true. Importantly, if he subjectively believes Fact A is true and deliberately attempts to create that same belief in the mind of the listener, he has not engaged in deceptive behavior even if Fact A is false.

The definition of lying imposes serious obstacles to an internally valid scientific study. First is the requirement that the *communicator* deliberately intend to mislead another. In the typical fMRI deception studies, subjects are placed in constructed and controlled environments, told to engage in certain behaviors, e.g., “steal” a watch or ring from a drawer, and then try to fool the researchers with their answers during the fMRI scan. What we do not know and cannot measure is whether the brain state of deliberate intent to mislead another is the same in the laboratory as it is in the real world.

Second is the problem of “forewarning.” As the definition indicates, this is a decision to deceive without being told or instructed to lie or attempt to deceive. Nancy Kanwisher describes the typical fMRI deception paradigm as an “instructed falsehood” which negates this essential element of the definition of deceit.³⁸¹

³⁷⁹ Aldert Pär Anders Granhag & Leif A. Strömwall, *Research on Deception Detection: Past and Present*, in THE DETECTION OF DECEPTION IN FORENSIC CONTEXTS 5 (Aldert Pär Anders Granhag & Leif A. Strömwall, eds., 2004) (quoting ALDERT VRIJ, DETECTING LIES AND DECEIT 6 (2000)).

³⁸⁰ *Id.*

³⁸¹ Nancy Kanwisher, *The Use of fMRI in Lie Detection: What Has Been Shown and What Has Not*, in USING IMAGING TO IDENTIFY DECEIT: SCIENTIFIC AND ETHICAL QUESTIONS, 12 (Emilio Bizzi, et. al. eds., 2009).

Kanwisher asserts that study subjects are not lying; they are merely following the researcher's instructions.³⁸²

In the context of interpersonal communications, whether one-on-one in private conversation or from the witness stand to a jury of twelve citizens, deception involves several cognitive processes. Kamila Sip and her colleagues explained the process of deception as requiring the communicator to continually weigh and analyze four mutually dependent factors before and during the process of deception: (1) information management; (2) risk management; (3) reputation management; and (4) impression management.³⁸³

In making the deliberate and voluntary decision to deceive another, the prevaricator must manage the information and keep track of both the truth and the untruths, suppress the truth, construct a lie that is reasonably consistent with the known facts, as well as monitor the feedback from the hearer to assess how effective he is in creating a false impression.³⁸⁴ At the same time, he must manage the risks of deception in terms of gains and losses and long-term consequences.³⁸⁵ Reputation management involves the need to convince oneself, as well as others, that a greater good was achieved by engaging in deceptive behavior and the ends justify the means.³⁸⁶ Impression management requires constant efforts at building trust in the minds of the listener and closely monitoring verbal and non-verbal feedback and making appropriate trust-building adjustments to further the deception.³⁸⁷

From a neuroimaging perspective, this process involves executive-level neural processes that are generally centered in the pre-frontal cortex, the same general area of the brain identified by

³⁸² *Id.*

³⁸³ Kamila Sip et al. *Detecting Deception: The Scope and Limits*, 12 TRENDS IN COGNITIVE SCIENCES 48, 49 fig.1 (2008).

³⁸⁴ *Id.*

³⁸⁵ *Id.*

³⁸⁶ *Id.*

³⁸⁷ *Id.*

most fMRI deception studies as active during deception.³⁸⁸ Importantly, however, the process described by Sip and her colleagues is one that is followed in deciding *whether* to deceive, as well as being active *during* the deception.³⁸⁹ Since the decision to deceive is an ongoing one, the cycle identified by Sip arguably occurs even if the subject decides not to deceive. An internally valid neuroimaging study to detect deception must isolate the neural processes that are applicable only to the deceptive behavior itself and eliminate those correlates that are also present when deception is not.³⁹⁰ Studies to date have not accomplished this important task.³⁹¹

The meta-analysis of twenty-three fMRI deception studies by Martha Farah and her colleagues found that “a number of experimental factors are confounded with the lie-versus-truth manipulation.”³⁹² For example, they surmised the disparity between the number of times a subject pressed the “yes” and “no” buttons as required by the study design may have an influence on the activation pattern observed and reflect the neural activity associated with an infrequent versus frequent motor response rather than deception.³⁹³ Similarly, they observed that in many studies, the brain activation patterns may reflect the cognitive process of either selecting the object of interest in the study or the effect of memory rather than the act of deception.³⁹⁴

Taken together, the research by Spence,³⁹⁵ Rusconi and Mitchener-Nissen,³⁹⁶ Kanwisher,³⁹⁷ and Farah³⁹⁸ all raise the serious

³⁸⁸ Annabelle M. Belcher & Adina L. Roskies, *Neuroscience Basics*, in A PRIMER ON CRIMINAL LAW AND NEUROSCIENCE 1, 24 (Stephen J. Morse & Adina L. Roskies eds. 2013).

³⁸⁹ Sip et al., *supra* note 383, at 49 fig.1.

³⁹⁰ Shen & Jones, *supra* note 350, at 874–76.

³⁹¹ *Id.*

³⁹² Farah et al., *supra* note 51, at 124.

³⁹³ *Id.* at 124–125.

³⁹⁴ *Id.* at 125.

³⁹⁵ Spence, *supra* note 46, at 11.

³⁹⁶ Rusconi & Mitchener-Nissen, *supra* note 31, at 1.

³⁹⁷ Kanwisher, *supra* note 381, at 7.

question of whether the fMRI deception research to date has really isolated deception. If not, the principles and methods relied upon to verify truth or identify deception based upon the BOLD response in the prefrontal cortex are not reliable. As Professors Francis Shen and Owen Jones have observed, “Researchers . . . are indeed measuring *something*—but they are not necessarily measuring ‘lying.’”³⁹⁹

ii. *The Problem of Reverse Inferences*

The inability of study designs to isolate those neural processes that are active *only* when deception is present raises the problem of reverse inferences. Most would agree that while not completely consistent, the neuroimaging studies of deception all show brain activation in similar regions.⁴⁰⁰ This result would lead one to conclude that when a subject is engaged in deception, certain general brain regions are active. Researchers then conclude that when a certain region is active, the subject is lying. Inferring behavior from brain activation in certain regions is only valid, however, if activation of that brain region *only* occurs when that behavior is present. The regions of the brain identified as active in fMRI deception studies are regions known to be associated with higher-level executive functions and are activated in a number of situations unrelated to deception.⁴⁰¹ As noted by Elena Rusconi and Timothy Mitchener-Nissen, “[J]ust because the prefrontal cortex is activated during deception it does not follow that every time the prefrontal cortex activates the individual is lying.”⁴⁰²

³⁹⁸ Farah et al., *supra* note 51, at 123.

³⁹⁹ Shen & Jones, *supra* note 350, at 875.

⁴⁰⁰ The active brain regions are usually displayed on a spatial MRI scan of a typical brain and are the result of the average regions of activation identified across the study participants. Because the resulting image of the group study is an average, no single participant may have displayed precisely the same areas of brain activation seen on the composite scan. Brown & Murphy, *supra* note 33, at 1151–52, fig.2.

⁴⁰¹ Rusconi & Mitchener-Nissen, *supra* note 31, at 5.

⁴⁰² *Id.*

Martha J. Farah and her colleagues identified this same flaw in their meta-analysis of fMRI deception studies. They found at least one study where the activation patterns in the prefrontal cortex were greater in truth-telling than in deception, precisely the opposite of the theory upon which fMRI lie detection is based.⁴⁰³ This observation illustrates the misleading results that can occur when one considers the difficulty of isolating the neural correlates of deception in the study design and then using reverse inferences to assume BOLD activation patterns in the prefrontal cortex indicate deception. Either one of those problems raises serious reliability concerns, but their combination poses a major obstacle in using fMRI as a reliable lie detector.

iii. *The Problem of BOLD Assumptions*

The underlying theory of fMRI as a lie detector relies upon the assumption that lying requires more brain energy than truth-telling and that more brain energy is identified by the BOLD response in the region of interest.⁴⁰⁴ Professor Brown and Dr. Murphy identified three important unanswered questions about the BOLD response that cast some doubt upon the underlying assumptions of BOLD fMRI as a reliable lie detector.⁴⁰⁵ They first found evidence that BOLD response may reflect neural activity related to synaptic input rather than output, the reverse of the theory upon which BOLD response to detect deception is based.⁴⁰⁶ Second, they also found a study suggesting that astrocytes, a structural but non-neural brain cell, may be involved in the BOLD response in some yet unknown fashion.⁴⁰⁷ If non-neural brain cells are involved in the BOLD response it raises questions about whether the BOLD response is an accurate gauge of neural activity in the first place. Finally, they noted a third researcher who found increases in neural

⁴⁰³ Farah et al., *supra* note 51, at 125, citing J. D. Greene and J. M. Paxton, *Patterns of Neural Activity Associated with Honest and Dishonest Moral Decisions*, 106 PROC. NATL. ACAD. SCI. 12506 (2009).

⁴⁰⁴ See *supra* notes 33–65 and accompanying text.

⁴⁰⁵ Brown & Murphy, *supra* note 33, at 1140–41.

⁴⁰⁶ *Id.* at 1140.

⁴⁰⁷ *Id.* at 1141.

blood flow in certain regions of the brain in anticipation of neural firing, but without actual neural firing.⁴⁰⁸ This finding also runs counter to the basic theory underlying the BOLD response as a reliable indicator of deception. Their survey of the relevant scientific literature led them to conclude:

Each new finding about the BOLD response suggests that our understanding of its neurological basis and correlation to brain activity is just scratching the surface. Understanding this phenomenon at the level of the neuron is critical to understanding if it is capturing little, some, or most of the brain's actual neuronal activity in response to an event. In turn, this knowledge is necessary to bridge the gap between a particular cognition or behavior and the neural mechanism underlying it.⁴⁰⁹

iv. *The Problem of Subject Compliance and Countermeasures*

Even the most carefully designed experiment will produce invalid results if the design is not followed scrupulously by the investigators and the participants. In the published studies, researchers generally took great pains to explain the process to ensure compliance with the test design. But this rehearsal and preparation may be a two-edged sword. While it is generally routine practice for subjects in fMRI detection studies to review the SIQs prior to the scan to ensure their understanding of the test requirements and reduce confusion, no one knows where the line between appropriate study preparation and extensive rehearsing is and what happens when that line is crossed.⁴¹⁰ If the story told in the scanner is so rehearsed that Sip's and colleagues' cycle of deception⁴¹¹ is on autopilot and the responses to the SIQs require virtually no mental effort, will neural patterns of deception be detectable? No one knows the answer to this fundamental question.

In the fMRI setting, movement in the scanner, whether slight or gross, intentional or unintentional, will introduce signal noise that will degrade the data and complicate analysis. Theoretically, engaging in some taxing mental activity, like complex

⁴⁰⁸ *Id.*

⁴⁰⁹ *Id.*

⁴¹⁰ Shen & Jones, *supra* note 350, at 876.

⁴¹¹ See *supra* note 383–87 and accompanying text.

mathematical calculations, while undergoing fMRI could alter neural activation patterns and confound the resulting data.⁴¹² While some published fMRI lie detection studies have addressed subject compliance and even encouraged participants to “beat the test,”⁴¹³ there has been no comprehensive study of countermeasures. Self-reporting by participants that they altered their breathing during the scan, visualized themselves in another environment, or delayed their responses to questions is not a substitute for controlled and careful studies of how participant non-compliance or deliberate employment of countermeasures might degrade the data and distort the results.

A recent study by Giorgio Ganis and his colleagues, however, has demonstrated the importance of the countermeasure issue.⁴¹⁴ In a version of the concealed information test, twenty-six Harvard University undergraduates were asked to view a series of six dates while in the scanner and respond by pressing a button with their right finger to indicate whether the date had any significance.⁴¹⁵ Of the six dates displayed during each scan, four were insignificant to the study participants.⁴¹⁶ The other two consisted of the subject’s birthdate and a personally insignificant “target” date to which the subjects were exposed prior to the scan.⁴¹⁷ To test the effectiveness of countermeasures, the participants were scanned three times.⁴¹⁸ In the first scan they were exposed to six dates, only one of which, the “target” date, was of significance and were asked to indicate their knowledge of the dates by pressing either the “yes” or “no” button with their right hand⁴¹⁹. The only response that should have elicited a “yes” response was the “target” date.⁴²⁰

⁴¹² Rusconi & Mitchener-Nissen, *supra* note 31, at 6.

⁴¹³ Kozel et al., *supra* note 31, at 612.

⁴¹⁴ Ganis et al., *supra* note 57, at 312.

⁴¹⁵ *Id.* at 313–15.

⁴¹⁶ *Id.*

⁴¹⁷ *Id.*

⁴¹⁸ *Id.*

⁴¹⁹ *Id.*

⁴²⁰ *Id.*

In the second scan the goal was to detect whether the participants had some concealed knowledge of a salient date.⁴²¹ They were instructed to respond truthfully to the irrelevant and target dates during this scan but to respond deceptively to the probe date, i.e., their birthdate.⁴²² The post-scan analysis was 100% effective in identifying the “lie” about their birthdate.⁴²³

Between the second and the third scan, the group was instructed in countermeasures to employ during the final scan.⁴²⁴ Specifically, they were told to imperceptibly move their left index finger, left middle finger, and left big toe before responding to three of the irrelevant dates in the final scan.⁴²⁵ This introduced not only a delay in response time, but also required a contralateral motor movement, i.e., movement on the left side of the body in addition to the movement necessary to press the response device with the right hand.⁴²⁶ In response to the other three dates in the sequence, they were told to respond truthfully to the “target” date and to the other irrelevant date, but to press “no” indicating no knowledge of their birthdate.⁴²⁷ After practicing the countermeasures, the subjects were scanned.

In the final scan, in which the countermeasures were employed before responding truthfully to three of the irrelevant dates, the accuracy rate in detecting the deceptive response to the salience of their birthdate dropped to only 30% with most of the incorrect classifications being false negatives.⁴²⁸ In other words, introducing imperceptible movements just prior to responding enabled the participants to conceal the lie about the salience of their own birthdate 70% of the time.

⁴²¹ *Id.* at 314.

⁴²² *Id.*

⁴²³ *Id.* at 315.

⁴²⁴ *Id.* at 313.

⁴²⁵ *Id.*

⁴²⁶ *Id.*

⁴²⁷ *Id.* at 313–14.

⁴²⁸ *Id.* at 315, 318 fig. 4b.

The ease at which the countermeasures could be learned and employed, coupled with the salience of the probe item, the subject's birthdate, led Ganis and his colleagues to conclude that:

[F]inding no difference between the activation to probes and the irrelevant in a typical CIT [concealed information test] paradigm does not imply that participants are honestly reporting ignorance about the probe; the result could instead be a false negative produced by covert countermeasures applied by individuals who have actually committed the crime under investigation.⁴²⁹

They cautioned against using neuroimaging deception detection paradigms in an applied setting until the vulnerability of the technology to countermeasures has been studied more thoroughly.⁴³⁰

Perhaps because the courts have had such a long history with polygraphy and countermeasures have plagued the reliability of the polygraph,⁴³¹ courts will most likely require experts to study the effect of countermeasures and develop means to detect their employment before admitting opinion testimony on truthfulness based on fMRI scanning. Leading researchers in fMRI lie detection technology understand and agree with the courts' concerns: "until conclusively proven otherwise, brain imaging should be expected to be no less sensitive to countermeasures than the polygraph."⁴³² To date, this standard has not been met.

v. *The Problem of Data Analysis*

Brain scans are data intensive. Managing and analyzing the data is a complex process dependent upon important choices and

⁴²⁹ *Id.* at 318.

⁴³⁰ *Id.*

⁴³¹ See, e.g., NATIONAL RESEARCH COUNCIL, THE POLYGRAPH AND LIE DETECTION 139 (Washington, DC: The National Academies Press, 2003) ("Perhaps the most serious potential problem with the practical use of the polygraph is the possibility that examinees—particularly deceptive ones—might be able to decrease the test's accuracy by engaging in certain behaviors, countermeasures, designed to produce nondeceptive test results.").

⁴³² Paul R. Wolpe, Kenneth R. Foster & Daniel D. Langleben, *Emerging Neurotechnologies for Lie detection: Promises and Perils*, 10 AM. J. BIOETHICS 40, 44 (2010).

tradeoffs along the way.⁴³³ Two such choices that influence internal validity are the threshold at which voxel activation⁴³⁴ is considered significant in constructing the fMRI image and the “base rate” of liars in the population tested. The first is related to the BOLD theory itself. The second is one of applying statistical principles to determine the sensitivity, specificity, positive predictive value, and negative predictive value of a given test. Both of these factors should be explored under the “protocols or standards” factor and the “error rate” factor in a *Daubert* inquiry.

(1) *Threshold of Voxel Activation*

As outlined in Part II, the BOLD response is the difference in cerebral blood flow, cerebral blood volume, and cell metabolism between the two brain states of interest, truth-telling and lying.⁴³⁵ Because the brain is always active, even when the subject is asleep, cerebral blood flow, cerebral blood volume, and cell metabolism are always present, as is every one of the brain’s over fifty billion neurons.⁴³⁶ The MRI scanner captures the magnetic resonance of this constant neural activity over the course of the scan.⁴³⁷ If hemodynamic activity was the only criteria by which to compare two brain states, the resulting images would show some hemodynamic activity in all areas of the brain at all times. But the BOLD response is a *relative* condition that compares hemodynamics between two brain states, such as lying and truth telling.⁴³⁸ By setting a threshold level at which to consider the hemodynamic response significant, the researchers can disregard

⁴³³ Jones, et al., *supra* note 57, at 9 (“It is important to remember that fMRI images are the result of a process a about a process; [m]ultiple choices and multiple steps go into determining exactly what data will be collected, how, and when—as well as into how the data will be analyzed and how it will be presented.”).

⁴³⁴ See *supra* notes 57–61 and accompanying text for an explanation of “voxels” in fMRI studies. Voxel activation refers to the hemodynamic changes that occur in the brain during the scan and are captured by the scanner.

⁴³⁵ See *supra*, Part II Evidence of Lies: Functional Magnetic Resonance Imaging.

⁴³⁶ See Aguirre, *supra* note 40, at S9–S11.

⁴³⁷ *Id.* at S10.

⁴³⁸ *Id.* at S8.

the “normal” hemodynamics of the brain and focus only on those areas that have a greater amount of neural activity. Setting the threshold level is part of the test design and therefore is a choice made by the researcher.⁴³⁹ There is no pre-determined level agreed upon by all research labs, and there is no standard set by scientific consensus.⁴⁴⁰

If the threshold is set low, far more brain regions will appear active than if the threshold is set high.⁴⁴¹ The low setting produces far more data points to analyze but will necessarily include activity in regions of the brain that may have nothing to do with the brain state under consideration.⁴⁴² By the same token, if the threshold is set high in an attempt to narrow the area of interest, some regions actively engaged in the process may be excluded from the analysis because the hemodynamic response in those voxels does not reach the threshold level set by the researcher.⁴⁴³ The fundamental decision as to the threshold level of voxel activation considered significant may explain the wide variety of brain regions seen as active in fMRI deception studies across labs and test paradigms.⁴⁴⁴

Craig Bennett and his colleagues dramatically illustrated this aspect of BOLD fMRI by placing a dead fish in an MRI scanner and exposing it to “a series of photographs depicting human individuals in social situations . . . [and] ask[ing] . . . [the fish] to determine what emotion the individual in the photo must have been

⁴³⁹ See, e.g., Rusconi & Mitchener-Nissen, *supra* note 31, at 6 (“The subjectivity inherent in fMRI analysis algorithms needs to be acknowledged and these algorithms opened up for scrutiny.”).

⁴⁴⁰ *Id.* (“[A]lgorithms are not purely objective artifacts; they encapsulate and reproduce all the subjectivity, bias and assumptions of the programmers, and some of these may differ each and every time they are applied.”).

⁴⁴¹ See Aguirre, *supra* note 40, at S11.

⁴⁴² *Id.*

⁴⁴³ *Id.*

⁴⁴⁴ See, e.g., Rusconi & Mitchener-Nissen, *supra* note 31, at 5 (“[A]ssuming increased oxygenated blood flow in specific brain regions denotes deception, scientists have not agreed with a degree of precision as to what these specific regions are.”).

experiencing.”⁴⁴⁵ The result: “[s]everal active voxels were discovered in a cluster located within the salmon’s brain cavity.”⁴⁴⁶ Obviously, a dead salmon could not have any neural activity, much less neural activity associated with discerning human emotion based upon pictures of people in various social activities. Nevertheless, the BOLD fMRI images showed several active voxels in the salmon’s brain.⁴⁴⁷ By processing the data through two different correction algorithms the false positive result was eliminated.⁴⁴⁸ They concluded that reliance on standard statistical thresholds for voxel activation and low minimum voxel cluster sizes are ineffective to ensure valid conclusions and argued that multiple comparison correction algorithms should be standard practice in the vast majority of fMRI studies.⁴⁴⁹ Of course, these correction algorithms themselves are constructed based on various assumptions and decisions to apply one particular statistical approach instead of another, thus bringing choice into the equation once again.⁴⁵⁰ Running multiple correction algorithms will tend to minimize the overall effect of a given choice, but the point remains that human choice, not the purely objective output of a computer, is influencing the data in a way that will influence the ultimate interpretation.⁴⁵¹

Unfortunately, most published fMRI studies do not go into all the detail necessary to identify the specific choices the researchers made from the study design to the colorful images said to represent a particular brain state.⁴⁵² This makes it difficult to assess the validity of the studies that underlie the principles and methods

⁴⁴⁵ Craig M. Bennett, Abigail A. Baird, Michael B. Miller & George L. Wolford, *Neural Correlates of Interspecies Perspective Taking in the Post-mortem Atlantic Salmon: An Argument for Multiple Comparisons Correction*, in OHBM, June 18–23, 2009, San Francisco, CA, 456 SA-PM.

⁴⁴⁶ *Id.*

⁴⁴⁷ *Id.*

⁴⁴⁸ *Id.*

⁴⁴⁹ *Id.*

⁴⁵⁰ Rusconi & Mitchener-Nissen, *supra* note 31, at 6.

⁴⁵¹ *Id.*

⁴⁵² Spence, *supra* note 46, at 11.

relied upon by an expert offering an fMRI-based opinion on whether a witness is lying or telling the truth. If fMRI-based expert opinion on witness truthfulness was admitted, juries would be confronted with the range of statistical choices available to construct an fMRI image, whether those choices are reliable in the abstract and whether they were reliably applied in the case at trial. Only after resolving those difficult questions could the jury assess the credibility of the expert and, finally, evaluate the substance of the opinion itself and decide whether to believe the witness whose credibility is in issue. The jury, essentially, becomes a committee ruling on the propriety of the science behind the fMRI BOLD theory for lie detection before it can accomplish its task of finding the facts in the case. Until the science matures and test design and statistical choices that must be made to process raw data into images interpretable by the expert become standardized,⁴⁵³ fMRI-based lie detection will have problems with internal validity.⁴⁵⁴ The jury's task of deciding the facts of the case will be hindered and not helped by the distraction and confusion necessary to fully analyze the internal validity of a study on fMRI lie detection before being able to apply the opinion based on that study to the witness in question.

(2) *The Problem of the "Base Rate" of Liars*

Using fMRI to identify liars or to verify truthfulness is a binomial task. That is, it places individuals into one of two groups depending upon whether the brain state of interest, deception, is present, much like a medical test identifies whether a patient has a given disease. One measure of the "error rate" of such tests is the statistical validity of a test results. These results can be expressed in terms of the test's "sensitivity" and "specificity."⁴⁵⁵ Sensitivity

⁴⁵³ Greely & Illes, *supra* note 33, at 337.

⁴⁵⁴ See Brown & Murphy, *supra* note 33, at 1154 ("Unless standardized and transparent criteria are followed to process the data and construct the activation map, the procedures employed could be subject to distortion.").

⁴⁵⁵ For a detailed explanation of calculating sensitivity and specificity in medical diagnostic and surveillance systems, see generally H. Kelly et al., *Estimating Sensitivity and Specificity from Positive Predictive Value, Negative*

refers to the ability of the test to correctly identify the individuals who actually lied.⁴⁵⁶ Also referred to as the “true positive rate,” the greater the sensitivity the better the test design is at identifying liars as liars and reducing the false positives (calling a truth teller a liar).⁴⁵⁷

Specificity, or the “true negative rate,” on the other hand, refers to the ability of the test to correctly identify those who did not display the brain state of interest. In the case of fMRI lie detection, this means correctly identifying those who actually told the truth. The greater the specificity the better the test design is at reducing false negatives (calling a liar a truth teller).⁴⁵⁸

Calculating the sensitivity and specificity of a lab experiment is rather straightforward. Sensitivity is determined by dividing the number of true positives (those the test correctly identified as telling a lie) by the total of the true positives and false negatives (those the test incorrectly identified as telling the truth when they actually lied).⁴⁵⁹

Specificity is determined by dividing the number of true negatives (those the test correctly identified as telling the truth) by

Predictive Value, and Prevalence: Application to Surveillance Systems for Hospital-acquired Infections, 69 J. HOSP. INFECTION 164 (2008). The binominal nature of fMRI lie detection studies readily permits the application of the well-established validity criteria of sensitivity, specificity, positive predictive value, and negative predictive value to the results. See, e.g., Wolpe et al., *supra* note 432, at 40 (calculating sensitivity, specificity, positive predictive value, and negative predictive value to analyze the accuracy of an fMRI lie detection study).

⁴⁵⁶ Christiana Drake & Richard A. Levine, *Sensitivity, specificity and other diagnostic measures with multiple sites per unit*, 26 CONTEMP. CLINICAL TRIALS 252, 252 (2005) (explaining the application of sensitivity and specificity calculations to medical diagnostic tests when attempting to determine whether the patient has the condition of interest).

⁴⁵⁷ Wolpe et al., *supra* note 432, at 41; WALTER SINNOTT-ARMSTRONG, *Neural Lie Detection in Courts*, in USING IMAGING TO DETECT DECEIT 36, 37 (E. Bizzi, et al. eds., 2009).

⁴⁵⁸ *Id.*

⁴⁵⁹ *Id.* at 42, Table 1.

the total of the true negatives and the false positives (those the test incorrectly identified as telling a lie).⁴⁶⁰

Equally important is a test's "positive predictive value" ("PPV") and "negative predictive value" ("NPV"). The PPV is the *probability* that a person who the test identified as having the brain state at issue actually has that brain state.⁴⁶¹ Conversely, the NPV is the *probability* that a person who did not exhibit the brain state of interest actually did not have the brain state of interest.⁴⁶² In the context of fMRI lie detection, the PPV expresses the probability that one who exhibits the neural correlates of deception while answering salient questions is actually lying, while the NPV is the likelihood that a person who did not exhibit the neural correlates of deception was actually telling the truth.⁴⁶³ Going beyond sensitivity and specificity to determine PPV and NPV evaluates the test design in terms of probabilities and approaches a more realistic "error rate" of the test.⁴⁶⁴

PPV is calculated by dividing the number of true positives by the total number of true positives and false positives.⁴⁶⁵ The resulting percentage is the likelihood that one whom the test identifies as a liar is actually a liar. Knowing the actual number of subjects who "lied" (the total of true positives and false positives) is required to calculate the PPV.⁴⁶⁶

NPV is calculated by dividing the number of true negatives by the total number of true negatives and false negatives. The resulting percentage is the likelihood that one whom the test identifies as a truth teller is actually a truth teller. Knowing the actual number of subjects who did not "lie" (the total of true negatives and false negatives) is required to calculate the NPV.⁴⁶⁷

⁴⁶⁰ *Id.*

⁴⁶¹ *Id.*

⁴⁶² *Id.* at 42.

⁴⁶³ *Id.*

⁴⁶⁴ *Id.*

⁴⁶⁵ *Id.* at 42, Table 1.

⁴⁶⁶ *Id.*

⁴⁶⁷ *Id.*

What is readily apparent from this brief discussion of the statistical methods used to evaluate the accuracy of a laboratory test is that the researcher must know the “ground truth” for each participant in the study in order to determine specificity, sensitivity, PPV, and NPV of the test. While that is not difficult in the controlled environment of the lab, it is virtually unknowable in real-world applications. After all, the whole purpose of administering a lie detector test to an individual, whether in a criminal investigation or security screening exercise, or in anticipation of trial testimony is to determine *whether* an individual is lying or telling the truth. In those settings, by definition, we do not know the “truth.”

When fMRI lie detection is employed as a screening tool, we do not know the ratio of truth tellers to liars in the population screened. Furthermore, when fMRI is employed in a forensic setting to determine whether an individual witness lied or told the truth, the sensitivity, specificity, PPV, and NPV depend upon the test paradigm of the underlying studies. Any difference between the laboratory studies and the actual forensic application will influence the “error rate” of the forensic application. The different factual scenarios, fMRI protocols, and data analysis techniques used by the various published studies on fMRI lie detection makes it difficult to calculate an overall error rate for the technology, generally, and virtually impossible to calculate for an individual forensic application.⁴⁶⁸

Daniel Langleben and Jane Moriarty question whether “overall error rates are a meaningful variable or whether error rates for each testing scenario need to be evaluated separately.”⁴⁶⁹ They argue, however, that “the inherent accuracy of lie detection within an individual subject is a prerequisite for further translational research [and that] understanding the error rate of a test is not complete until its positive and negative predictive powers are also

⁴⁶⁸ Daniel D. Langleben & Jane C. Moriarty, *Using Brain Imaging for Lie Detection: Where Science, Law, and Policy Collide*, 19 PSYCH. PUB. POL. & L. 222, 229 (2013).

⁴⁶⁹ *Id.*

known.”⁴⁷⁰ Complicating determination of the error rate is the need to know the “base rate” of liars within the population tested.⁴⁷¹

In a 2005 study, Paul Wolpe, Kenneth Foster, and Daniel Langleben illustrated the significance that the “base rate” of liars within the tested population can have on the predictive value of an fMRI lie detection scan.⁴⁷² Using Ben-Shakhar’s and Elaad’s meta-analysis of 123 polygraph studies using the Guilty Knowledge Test paradigm, in which the sensitivity and specificity ranged between 70% and 85%,⁴⁷³ Wolpe, Foster, and Langleben calculated the PPV and the probability of a false positive in a hypothetical population group of criminal suspects with an assumed “base rate” of liars of 50% and a group of Department of Energy employees with an assumed “base rate” of liars of 0.1%.⁴⁷⁴ They found when the prevalence of liars within the tested group was low, “the test will yield far more false-positive than true-positive results; about one person in five will be incorrectly identified by the test.”⁴⁷⁵ They also found that even in a population with a “base rate” of liars of 50%, the PPV is “quite low.”⁴⁷⁶ Their study led them to conclude that “[n]ew technologies may—or may not—improve the situation, but clearly a very large improvement in the specificity of the test would be needed for its performance to be acceptable for most forensic or security purposes.”⁴⁷⁷

c. *External Validity*

External validity is a measure of how well the laboratory results can be applied to those who did not participate in the study, whether it is the population at large or to a specific individual.⁴⁷⁸

⁴⁷⁰ *Id.*

⁴⁷¹ Wolpe et al., *supra* note 432, at 42.

⁴⁷² *Id.*

⁴⁷³ G. Ben-Shakhar & E. Elaad, *The Validity of Psychophysiological Detection of Information with the Guilty Knowledge Test: A Meta-analytic Review*, 88 J. APPLIED PSYCH. 131, 132 (2003).

⁴⁷⁴ Wolpe et al., *supra* note 432, at 43.

⁴⁷⁵ *Id.*

⁴⁷⁶ *Id.*

⁴⁷⁷ *Id.*

⁴⁷⁸ LAWLESS ET AL., *supra* note 335, at 39.

The typical fMRI lie detection study usually deals with a small number of participants who are mostly undergraduate students. They are, generally speaking, young, healthy, eager to participate and further the cause of science, and without significant social or medical histories, such as drug or alcohol addiction, that might confound the results of the study. Ethical concerns require researchers to make sure the study participants are suitable candidates for the study and will not be harmed by the study procedures.⁴⁷⁹

i. *The Problem of Population Differences*

To be externally valid, however, the study results must be applicable to a wider population or demographic. In the forensic setting, one takes his subject as he finds him. In other words, applying fMRI lab research based on young, healthy, and unmedicated volunteers and comparing it to fMRI results based on individuals caught up in the criminal justice system ignores the difference in those two population groups. Mental illnesses, personality disorders, drug abuse, alcohol addiction, which are all factors screened for and eliminated in the lab studies, are encountered routinely in the criminal justice system. Whether any one or a combination of these factors would influence the outcome of an fMRI scan is unknown because it has not been studied.⁴⁸⁰

⁴⁷⁹ See Kozel et al., *supra* note 31, at 606 (“The subjects were healthy unmedicated adults ages 18-50 years who were screened with a Structured Clinical Interview for DSM-IV Axis I Disorders (SCID-I) . . . a pre-MRI screening form, a medical history, and a physical exam. They were evaluated with an Annett Handedness Scale . . . and the State-Trait Anxiety Inventory (STAI) A urine sample was obtained for a drug urinalysis and a urine pregnancy test if a female of child-bearing potential.”).

⁴⁸⁰ See, e.g. Kozel, et al., *supra* note 377, at 228 (“[W]hether fMRI deception testing would work is unknown for participants who are taking a medication, who have a significant psychiatric or medical condition, or who are outside the 18-50 year age range[,] [f]uture studies will need to be performed involving these populations.”); Simpson, *supra* note 31 at 494 (“There has been no testing of fMRI lie detection paradigms in juveniles, the elderly, or individuals with Axis I and/or Axis II disorders, such as substance abuse, antisocial personality

The significant difference between the demographics of the study participants and those typically seen in the criminal justice system does not exist in all potential forensic uses. For example, a “white collar” criminal defendant may exhibit all the characteristics of the typical study participant. By the same token, a percipient witness in a criminal or civil case may very well possess the same characteristics of the typical study population. The point is that external validity is an important consideration in every application of fMRI lie detection research and must be evaluated in each instance. In some situations weak external validity may render the application of the technology unreliable, while in other situations the similarity between the study participants and the individual may be sufficient to satisfy this important aspect of scientific research.

ii. *The Problem of Cultural Differences*

Equally problematic from an external validity standpoint is the cultural influence of deception. From a psycho-social perspective, “culture” refers to “features of human groups that typically vary according to geographic areas and which depend upon social learning; it includes shared attitudes, practices, and beliefs, together with languages and religions.”⁴⁸¹ While some fMRI studies have noted the ethnicity of the study subjects,⁴⁸² there has been no systematic consideration of the influence of culture on the neural correlates of deception. If lying is a social construct and deception involves intentionally creating a false belief in the mind

disorder, mental retardation, head injury, or dementia. It is unclear whether and how such diagnoses would affect the reliability of the approach.”).

⁴⁸¹ Tommaso Bruni, *Cross-Cultural Variation and fMRI Lie detection*, TECHNOLOGIES ON THE STAND: LEGAL AND ETHICAL QUESTIONS IN NEUROSCIENCE AND ROBOTICS 129 (2012).

⁴⁸² See, e.g., Tatia M. C. Lee et al., *Lie Detection by Functional Magnetic Resonance Imaging*, 15 HUMAN BRAIN MAPPING 157, 159 (2002) (identifying study participants as “native Chinese (Mandarin) speakers from Mainland China”).

of another, then the social and cultural milieu in which the exchange takes place may influence the brain's processing.⁴⁸³

iii. *The Problem of Group to Individual (G2i) Inference*

Another important aspect of internal validity is whether BOLD responses generated by group-averaged studies can be applied to individuals.⁴⁸⁴ Most fMRI lie detection studies have averaged the degree of activation and location of active voxels of the study's participants to create a graphical image that displays the average of the neural correlates for the group.⁴⁸⁵ Because the study produces an average of brain activation, some members of the group will have more areas active; some will have less. Some will show activation in areas that others do not. Conceivably, a given participant's brain activation pattern may fall completely outside the graphical image constructed on the average pattern of activation across a group.⁴⁸⁶

Extrapolating the group-averaged data to make definitive determinations about an individual is problematic, at best.⁴⁸⁷ Science is concerned with universal conditions in populations; such an approach increases our understanding of ourselves and the world in which we live. A trial is concerned about the conduct of an individual. Does the individual about whom the law is concerned share precisely the same attributes as the average data from the subjects of the underlying studies? Unless and until more studies are done with larger numbers of participants, the attempt to apply group-averaged data to individuals will raise serious external

⁴⁸³ Rusconi & Mitchener-Nissen, *supra* note 31, at 6.

⁴⁸⁴ For a discussion of the problem of group to individual inference (G2i) in scientific expert testimony, generally, see generally Faigman, Mohahan & Slobogin, *supra* note 279, at 23.

⁴⁸⁵ Kanwisher, *supra* note 381, at 7.

⁴⁸⁶ *Id.*

⁴⁸⁷ See, e.g., *id.*; Shen & Jones, *supra* note 350, at 881 (2011) ("It is an inferential challenge to move from group-averaged neuroscience data to individual assessments.").

validity problems and directly undermine the trustworthiness of an opinion based on that data.⁴⁸⁸

d. *Ecological Validity*

Ecological validity is a measure of the correlation between the controlled and structured laboratory conditions of the study and what one would experience in the uncontrolled and unstructured dynamics of a real-world setting.⁴⁸⁹ This inquiry looks at the underlying studies upon which the principles and methods used by the expert are derived. None of the studies relied upon by proponents of fMRI lie detection were designed to measure the neural correlates of deception in a real-world environment. Dr. Laken, one of the leading proponents of fMRI lie detection and the scientist who has studied this area more than perhaps anyone else, acknowledged, “I don’t know of a way to do real world scenario testing.”⁴⁹⁰ Dr. Laken was, however, willing to assume that the BOLD response observed by researchers in laboratory settings, using undergraduates who were instructed to lie about their involvement in a mock crime, would be the same as that of a criminal defendant facing a prison sentence.⁴⁹¹

Another ecological validity problem is illustrated quite well by the *Semrau* case itself. The fMRI deception studies generally require the participants to engage in some activity and then “lie” about their involvement.⁴⁹² Apart from the difference between the artificial laboratory condition and what might exist in the real world, the typical test paradigm involves behavior or action on the part of the participants.⁴⁹³ In *Semrau*, on the other hand, Dr. Semrau was not asked about whether he engaged in certain

⁴⁸⁸ *Id.*

⁴⁸⁹ *Id.*

⁴⁹⁰ Testimony of Steven Laken, Transcript of Proceedings, May 13, 2010, Vol. II at 191, *United States v. Semrau*, No. 07CR10074-IJPM (W.D. Tenn.).

⁴⁹¹ *Id.*, May 14, 2010, Vol. IV at 39–40.

⁴⁹² Spence, *supra* note 46, at 13.

⁴⁹³ *Id.* at 14–21, Table 1 (describing studies).

behavior.⁴⁹⁴ Rather, he was asked about whether he had a certain state of mind or intent at a point in his past.⁴⁹⁵ No fMRI deception studies to date have explored whether lying about a past state of mind as opposed to past behavior would engage the same regions of the brain to the same extent. Assuming the neural correlates of deception when the subject lied about engaging in certain behaviors are the same when the lie involves a past state of mind instead of conduct or behavior is a question the neuroscientists have not explored.

6. *Reliable Application of Reliable Principles and Methods*

The sixth and final requirement imposed by Rule 702 is that the expert must reliably apply the appropriate reliable principles and methods to sufficient facts and data in reaching his opinion. This inquiry will always be case-specific. In the context of fMRI-based lie detection, this involves examining the specifics of the fMRI scan of the witness in question, the creation of the graphic images of the BOLD response, and the expert's interpretation of those images.

Assuming there are standards or protocols that guide the application of the principles and methods to individual subjects, the inquiry will be whether the expert followed those standards or protocols in reaching the opinion offered in the case. Protocols applicable to individual lie detection have not been published in the scientific literature, though companies offering commercial services claim to follow their own proprietary protocols.⁴⁹⁶

The importance of the case-specific analysis of this requirement of Rule 702 was apparent in *Semrau*. Dr. Laken's first scan of Dr. Semrau concerning the AIMS testing issue revealed Dr. Semrau

⁴⁹⁴ *United States v. Semrau*, No. 07-10074, 2010 WL 6845092, at *4 (W.D. Tenn. June 1, 2010).

⁴⁹⁵ *Id.*

⁴⁹⁶ See, e.g., NO LIE MRI, <http://www.noliemri.com/products/Overview.htm> ("No Lie MRI is a proprietary product that objectively measures intent, prior knowledge, and deception using algorithms to automatically analyze functional Magnetic Resonance Imaging (fMRI).") (last visited March 8, 2014).

was being deceptive.⁴⁹⁷ Dr. Laken surmised that the deception result was probably caused by fatigue.⁴⁹⁸ He then arranged for a repeat scan which revealed no deception.

D. Frye: *The General Acceptance Standard*

At the time of this writing, the only other courts to consider fMRI as a lie detector are the Supreme Court of New York in *Wilson v. Corestaff Services, L.P.*,⁴⁹⁹ a civil action for retaliation after plaintiff reported sexual harassment by a fellow employee on the job, and *State v. Smith*,⁵⁰⁰ a case where the defendant, a veteran of the Iraq War, was accused of murdering his roommate. Both courts rejected the fMRI evidence for failing to meet the “general acceptance” standard followed by their respective jurisdictions.

In *Wilson*, plaintiff claimed that the defendant’s manager, Edwin Medina, instructed another Corestaff employee, Ronald Armstrong, to deny plaintiff a temporary work assignment because she complained of sexual harassment in an earlier temporary assignment.⁵⁰¹ Armstrong was plaintiff’s only witness to the alleged retaliatory statement made by Medina and Armstrong’s credibility as a witness was central to plaintiff’s ability to prove the retaliatory action by her employer.⁵⁰² Armstrong underwent fMRI testing by Dr. Laken who concluded that Armstrong was being truthful when he answered SIQs that Medina made the retaliatory statement.⁵⁰³ Plaintiff intended to call Dr. Laken to bolster Armstrong’s testimony as to Medina’s instructions not to provide temporary work assignments to plaintiff because she complained of sexual harassment.⁵⁰⁴ The defendant moved to exclude Dr.

⁴⁹⁷ *United States v. Semrau*, No. 07–10074, 2010 WL 6845092, at *8 (W.D. Tenn. June 1, 2010).

⁴⁹⁸ *Id.*

⁴⁹⁹ 28 Misc. 3d 425, 900 N.Y.S.2d 639 (N.Y. Sup. Ct. 2010).

⁵⁰⁰ Memorandum Opinion and Order, *Maryland v. Smith*, No. 106589C (Cir. Ct. Montgomery Cty., M.D., Oct. 3, 2012).

⁵⁰¹ *Wilson*, 28 Misc. at 426, 900 N.Y.S.2d at 640.

⁵⁰² *Id.*

⁵⁰³ *Id.*

⁵⁰⁴ *Id.*

Laken as an expert witness under *Frye*, the standard for admissibility of scientific evidence in New York.⁵⁰⁵

Expert testimony based on scientific theory is admissible in New York if the following conditions are met: (1) the scientific theory, principles, or procedures have gained general acceptance in the relevant scientific community; (2) the testimony comes from a qualified expert; and (3) the topic of the expert testimony is beyond the common knowledge of the average juror.⁵⁰⁶ The trial court found that Dr. Laken's testimony went to a collateral matter, the credibility of Armstrong, which was clearly within the ability of the jury to determine without the aid of expert testimony.⁵⁰⁷ Additionally, the court expressed great reservation and skepticism about ever admitting expert testimony on the credibility of a witness:

How complex and confusing would a trial become for the jury if it were faced with conflicting expert opinions, each with scientific authority to support it, upon the collateral matter of credibility. The first question would be the credibility of the experts, and then the credibility of the witness. The battle of the experts might well be such that the jury would lose sight of the issues or, at the very least, would tend to regard the opinion of the expert as determinative of credibility of the witness rather than to consider it only as one factor of many to be considered in concluding whether a witness is telling the truth.⁵⁰⁸

While the court held that the failure of the proffered testimony to meet the third prong of the *Frye* test was sufficient to exclude Dr. Laken's testimony, the trial judge commented that "even a cursory review of the scientific literature demonstrates that the plaintiff is unable to establish that the use of the fMRI test to determine truthfulness or deceit is accepted as reliable in the relevant scientific community."⁵⁰⁹ The court granted the defendant's motion to exclude Dr. Laken's testimony and denied plaintiff's

⁵⁰⁵ *Id.*

⁵⁰⁶ *People v. LeGrand*, 8 N.Y.3d 449, 452, 835 N.Y.S. 2d 523, 375 (N.Y. App. 2007).

⁵⁰⁷ *Wilson*, 28 Misc. at 427–29, 900 N.Y.S.2d at 641–42.

⁵⁰⁸ *Id.* at 428, 900 N.Y.S.2d at 641–42 (quoting *People v. Williams*, 6 N.Y.2d 18, 27, 187 N.Y.S.2d 750, 757 159 N.E.2d 549, 554 (N.Y. 1959)).

⁵⁰⁹ *Id.* at 429, 900 N.Y.S.2d at 642.

motion for a full *Frye* hearing on the general acceptance of fMRI as a lie detector.⁵¹⁰

In *Smith*, the defendant underwent fMRI scanning by No Lie fMRI, a company that, according to its website, uses technology that “represents the first and only direct measure of truth verification and lie detection in human history!”⁵¹¹ Smith offered expert opinion testimony that the BOLD response during Smith’s fMRI indicated he was being truthful when he denied shooting McQueen.⁵¹² In an effort to convince the trial court that fMRI lie detection was generally accepted by the scientific community and met Maryland’s standard for admitting novel scientific testimony, Smith argued that in twenty-five peer-reviewed scientific journal articles on fMRI lie detection, none found that “the technology does *not* work.”⁵¹³ He also argued that in over ten years of research no published studies refute the validity or reliability of fMRI lie detection.⁵¹⁴

The state countered with scientific articles questioning the reliability of fMRI lie detection and offered the testimony of a neuroscientist declaring that the neuroscience community did not yet accept fMRI lie detection.⁵¹⁵

The court applied the Maryland general acceptance standard⁵¹⁶ and found that “it is clear to the Court that the use of fMRI to detect deception and verify truth in an individual’s brain has not achieved general acceptance in the scientific community.”⁵¹⁷ The “tepid approval of a few scholars through twenty-five journal

⁵¹⁰ *Id.*

⁵¹¹ NO LIE FMRI, <http://www.noliemri.com/> (last visited Mar. 13, 2014).

⁵¹² Memorandum Opinion and Order, *Maryland v. Smith*, No. 106589C at 4 (Montgomery Cty, MD, Oct. 3, 2012).

⁵¹³ *Id.* (emphasis in original).

⁵¹⁴ *Id.* at 5.

⁵¹⁵ *Id.*

⁵¹⁶ See *Reed v. State*, 283 Md. 374 (1978) (adopting *Frye* test).

⁵¹⁷ Memorandum Opinion and Order, *Maryland v. Smith*, No. 106589C at 5–6 (Montgomery City, MD, Oct. 3, 2012).

articles does not persuade this Court that such acceptance exists,” the court reasoned.⁵¹⁸

Wilson and *Smith* highlight the gap between the neuroscience community and the proponents of fMRI as a scientifically valid and reliable lie detector. Even some proponents and researchers of the new technology acknowledge that more work needs to be done.⁵¹⁹ Aside from the few published studies of small groups of volunteers undergoing fMRI scanning under laboratory conditions, which all acknowledge further research is required, the professional literature uniformly demonstrates a cautious attitude within the relevant scientific community.

VI. RULES OF EVIDENCE: BALANCING PROBATIVE VALUE VERSUS PREJUDICIAL EFFECT

As the discussion of impeachment and rehabilitation indicated, the trial judge has tremendous discretion when it comes to admitting evidence to impeach or rehabilitate a witness. Rule 611(a) codifies the inherent authority of the trial judge and provides textual support for much of the discretionary authority of the judge. It establishes goals for the conduct of the trial and places the responsibility for the “effective working of the adversary system” squarely on the shoulders of the trial judge.⁵²⁰ Rule 611(a) emphasizes the effective search for truth without wasting time and without subjecting witness to harassment or undue embarrassment. While Rule 611(a) establishes desirable objectives for the conduct of the trial, Rule 403 establishes a test for the admission of evidence that furthers those objectives.

⁵¹⁸ *Id.* at 4.

⁵¹⁹ See, e.g., Spence, *supra* note 46, at 24 (“While brain imaging is fashionable, and its data susceptible to multiple, aesthetic modes of presentation, further empirical data are required to justify its future application to the field of lie detection.”); Langleben, *supra* note 31, at 6 (predicting that demand and technical feasibility “are likely to produce a clinical fMRI-based lie detector in the near future”).

⁵²⁰ FED. R. EVID. 611(a) (advisory committee’s note) (1972).

Rule 403 permits the exclusion of otherwise relevant and admissible evidence if the probative value⁵²¹ of the evidence for the point for which it is offered is substantially outweighed by the danger of unfair prejudice, confusion of the issues, misleading the jury, waste of time, or the needless presentation of cumulative evidence.⁵²² The balancing of probative value versus prejudicial effect has played a prominent role over the years in consistently excluding expert testimony of witness credibility generally, and polygraph evidence specifically.⁵²³ It is also clear that Rule 403 operates independently of Rule 702 and evidence that meets the Rule 702 standard may still be excluded by Rule 403.⁵²⁴

With regard to fMRI-based opinion of witness truthfulness, the Rule 403 equation considers many of the same factors considered in the “fit” analysis under Rule 702.⁵²⁵ Probative value is higher the closer the “fit” between the opinion and the issues to be decided by the jury. But also included in the Rule 403 balancing is the availability of other evidence probative of the same point,⁵²⁶ the relative importance in the case of the point for which the evidence is offered,⁵²⁷ and the need for the evidence in the context of the issues in dispute.⁵²⁸

Against the weight of probative value, the trial judge places the danger of unfair prejudice, the risk of confusing the issues,

⁵²¹ “Probative value” is the strength of the logical chain of inferences from the item of evidence to the fact it is offered to prove.

⁵²² The use of the term “prejudicial effect” includes all of the countervailing factors to probative value. This does not imply that evidence that misleads the jury, confuses the issues, wastes time, or is cumulative is the same as evidence that unfairly prejudices the opponent by inappropriately appealing to emotion. It is used merely as label for the side of the scale opposite probative value.

⁵²³ See *supra* note 287 (listing cases excluding expert testimony on credibility).

⁵²⁴ *Daubert v. Merrell Dow Pharm. Inc.*, 509 U.S. 579, 594 (1993) (explaining that Rule 403 applies to expert testimony); *United States v. Ramirez-Robles*, 386 F.3d 1234, 1246 (9th Cir. 2004) (finding that Rule 702 and Rule 403 “address different aspects of evidence and therefore act independently”).

⁵²⁵ See *supra* notes 276–312 and accompanying text.

⁵²⁶ *Old Chief v. United States*, 519 U.S. 172 (1997).

⁵²⁷ *United States v. Herman*, 589 F.2d 1191, 1198 (3d Cir. 1978).

⁵²⁸ *United States v. Cook*, 538 F.2d 1000, 1004 (3d Cir. 1976).

misleading the jury, causing undue delay or waste of time, and needlessly presenting cumulative evidence.⁵²⁹ Unfair prejudice usually refers to an improper appeal to decide the case on emotion rather than the force of the probative evidence,⁵³⁰ but it also encompasses the consideration that the jury may give an item of evidence more weight than it deserves.⁵³¹ Evidence that is confusing or misleading distracts the jury from the central issues in the case and/or raises issues to a prominence that they do not warrant.⁵³² Undue delay and waste of time is, as Justice Holmes famously remarked, a “concession to the shortness of life.”⁵³³ The amount of time it takes to present the evidence, as well as any counter-evidence, is a very real and important factor in the context of our over-burdened justice system. Left unfettered, lawyers will offer proof of every fact remotely connected to the case through several different means. Without some tempering effect from the trial judge, cases would last even longer than they do now.

Rule 403 balancing must be done in the context of the legal and factual issues in a given case and the nature of the evidence available to prove the point in question. While Rule 403 balancing in the abstract does little more than repeat the language of the rule itself, we know enough about fMRI-based expert opinion on truthfulness and the contexts in which it would be offered to apply the Rule’s standards to common scenarios.⁵³⁴ *Semrau* provides a

⁵²⁹ Evidence that misleads or confuses the jury may also be categorized as “unhelpful” under Rule 702, further illustrating the overlap between the two rules.

⁵³⁰ *United States v. Pintado-Isiordia*, 448 F.3d 1155, 1158 (9th Cir. 2006).

⁵³¹ *United States v. Looking Cloud*, 419 F.3d 781, 785 (8th Cir. 2005).

⁵³² *Harless v. Boyle-Midway Div.*, 594 F.2d 1051, 1058 (5th Cir. 1979).

⁵³³ *Reeve v. Dennett*, 11 N.E. 938, 944 (1887).

⁵³⁴ Professor Teneille Brown and Dr. Emily Murphy, PhD., explored the reliability and probative value of fMRI-based testimony as evidence of a criminal defendant’s past mental state. They found that the computer-generated images of the suspect’s brain produced by the fMRI scan and the expert testimony interpreting those images describing the mental state of the criminal defendant to be unreliable and a hindrance to the fact-finding process: “[The fMRI evidence] promotes unfair prejudice and confusion of the issues because it causes jurors to ground their decision making in emotional responses to images

convenient example, but it did not address all the arguments on either side of the equation.

The government moved to exclude Dr. Laken's testimony under Rule 702 and, alternatively, under Rule 403, arguing the probative value was substantially outweighed by the danger of unfair prejudice to the government.⁵³⁵

Three factors figured prominently in the magistrate judge's decision to also exclude the evidence under Rule 403: (1) the unilateral nature of the exam;⁵³⁶ (2) the use of the evidence to bolster credibility;⁵³⁷ and (3) the gap between the opinion of "overall" truthfulness and the specific facts alleged in the indictment.⁵³⁸

A. *Probative Value: Unilateral Examinations*

In assessing the probative value of Dr. Laken's opinion, the magistrate judge first noted that Dr. Semrau's fMRI scan was done without notice to or participation by the government. Dr. Laken admitted that if the fMRI scans had shown Dr. Semrau was lying, the results would have never been revealed to the government.⁵³⁹ Drawing upon precedent involving polygraph examinations, the magistrate judge found the "nothing to lose" aspect of the unilateral examination diminishes the probative value of the

and distracts jurors from logical errors [in the basis of the opinion], thus causing them to make decisions founded on improper bases." See Brown & Murphy, *supra* note 33, at 1204.

⁵³⁵ United States v. Semrau, No. 07-10074, 2010 WL 6845092, at *14 (W.D. Tenn. June 1, 2010).

⁵³⁶ *Id.*

⁵³⁷ *Id.*

⁵³⁸ *Id.* at *16.

⁵³⁹ Transcript of Proceedings, May 13, 2010, Vol. II at 207, United States v. Semrau, No. 07CR10074-1JPM (W.D. Tenn.) ("If Dr. Semrau failed [the fMRI test], and my conclusion was the he failed, he didn't pass the test, you [the government] would never know that. There are no penalties for failing the test there.").

proffered expert testimony on the subject's truthfulness.⁵⁴⁰ The Sixth Circuit affirmed the magistrate judge's analysis on this point and affirmed its appropriateness in justifying the exclusion under Rule 403.⁵⁴¹

Whether the unilateral polygraph exam is good precedent for evaluating the probative value of an fMRI exam raises an interesting issue. The theory of reduced probative value of a unilateral polygraph exam is that because there are no adverse consequences from failing the exam, there is little or no stress on the witness.⁵⁴² If he fails the exam, no one will know and he will not suffer any adverse consequences because he failed. Because polygraph is based on the notion that heart rate, respiration, blood pressure, and skin conductivity increase with stress and lying produces stress, the absence of any consequences for lying reduces or eliminates the underlying stress upon which the test is based.⁵⁴³

fMRI is not grounded on a theory of stress producing an identifiable BOLD response. In this respect, the reduction of stress due to the absence of any adverse consequences of failing an fMRI test does not necessarily undermine the probative value of the opinion based on the test. In the MRI setting, stress could be a confounding variable that the algorithms cannot identify and account for when processing the data from the scan. Stress may also increase the likelihood of movement of the subject in the scanner and introduce other artifacts and noise that could degrade the quality of the data. It stands to reason that a stress-free subject may be more comfortable in the scanner, more relaxed, better able to concentrate on the task at hand, and to otherwise cooperate in a way that minimizes movement and other confounds that may distort the data. Conceivably, a stress-free subject may be a better

⁵⁴⁰ See, e.g., *United States v. Ross*, 412 F.3d 771, 773–74 (7th Cir. 2005); *United States v. Thomas*, 167 F.3d 299, 308–09 (6th Cir. 1999); *United States v. Sherlin*, 67 F.3d 1208, 1217 (6th Cir. 1995).

⁵⁴¹ *United States v. Semrau*, 693 F.3d 510, 523–24 (6th Cir. 2012).

⁵⁴² NATIONAL RESEARCH COUNCIL, *THE POLYGRAPH AND LIE DETECTION* 13 (2003).

⁵⁴³ *Id.*

subject for fMRI truth detection and may produce a more reliable result, not a less reliable one.

While the stress theory of polygraph that spawned the virtual *per se* rule of exclusion of unilateral tests may or may not apply to the fMRI, a unilateral fMRI is of questionable probative value for other reasons. First, researchers have not studied fMRI in situations where grave consequences might result from failure of the test. We simply do not know whether the BOLD response in one who is facing serious jail time if he is not believed, regardless of whether the opposing side is made aware of the result, is the same as an undergraduate psychology student who is paid fifty dollars to participate in a controlled study. The stress of consequences could play a role in the BOLD response, or it could not. The stress of consequences could make the collection and analysis of the MRI data more complex if anxiety and stress made it more difficult for the witness to lie still and cooperate fully with the examiner. The absence of any research on this important question leaves the expert to assume that the lack of adverse consequences will not impact the test. This, in turn, makes the testing environment significantly different from in-court testimony where adverse consequences abound. Accepting untested assumptions on such a critical question is the antithesis of the scientific method and seriously undermines confidence in the test. This, in turn, reduces the probative value of the test when it moves from the neuroscience lab to the courtroom.

A second reason why unilateral fMRI exams have little probative value is that the opposing party is excluded from the process of developing the SIQs that will serve as the basis for the test itself. Excluding the opposing party from the development of SIQs permits the proponent to craft the questions consistent with his own factual and legal theory of the case. The resulting opinion of “truthful” is then based upon only those issues fairly encompassed by the SIQs and may not extend to other important factual questions—questions the opposing side deem critical to its theory of the case. The dynamics of adversarial litigation necessarily include differences over the facts themselves, but differences over the importance of those facts—and whether facts unimportant to one side’s theory of the case are important to the

opponent's side—are omnipresent. A unilateral exam excludes consideration of the opposition's theory or, at best, frames the opposition theory through the perspective of the proponent.⁵⁴⁴ In either case, the resulting opinion on truthfulness will not address the credibility question from a perspective that objectively considers both sides of the case, thus reducing the probative value of the opinion on the credibility issue.⁵⁴⁵

B. *Probative Value: Specificity of the Opinion*

The magistrate judge found the probative value of Dr. Laken's opinion was lacking because Dr. Laken could not "offer any opinion as to whether Dr. Semrau was deceptive or truthful as to any specific SIQ."⁵⁴⁶ An opinion as to "overall" truthfulness without an ability to determine the truthfulness of responses to individual SIQs, could not "assist the jury in deciding whether Dr. Semrau's testimony is credible."⁵⁴⁷

⁵⁴⁴ In *Semrau*, the SIQs were actually drafted and submitted to Dr. Laken by Mr. Houston Gordon, Dr. Semrau's defense counsel:

Q: All right. The specific incident questions that you asked, though, that were on scan number one revolved around these two CPT codes, is that correct?

A: That's correct. Those were the questions that were presented.

Q: Where did those questions come from? Can you tell me that?

A: They came from Dr. Houston—they came from attorney Gordon's office.

Q: All right. So Mr. Gordon actually drafted—to your knowledge drafted the specific incident questions.

A: Correct.

Testimony of Steven Laken, Transcript of Proceedings, May 13, 2010, Vol. I at 137, *United States v. Semrau*, No. 07CR10074-1JPM (W.D. Tenn.)

⁵⁴⁵ An analysis of the SIQs by the opponent after the scan would give the opponent an opportunity to point out, from the opponent's perspective, additional SIQs and flaws in the SIQs actually used. The extent and nature of the opponent's objections to the SIQs used would still be factors to consider in determining the probative value of the opinion.

⁵⁴⁶ *United States v. Semrau*, No. 07-10074, 2010 WL 6845092, at *16 (W.D. Tenn. June 1, 2010).

⁵⁴⁷ *Id.* Evaluating the probative value of an item of evidence by analyzing whether it will assist the jury in his core function of determining credibility

An opinion that the witness was “overall” truthful during the scan may have some probative value as to credibility. The jury might infer that if he was “overall” truthful in the scan he is “overall” truthful in court, and if he is “overall” truthful in court he may be “overall” not guilty of the charged offenses. But Rule 403 is concerned with the weight of the probative value and must balance that against the weight of the countervailing considerations. If an SIQ addresses a critical fact alleged in the indictment, the guilt or innocence of the accused may well turn upon whether the jury finds that fact established. An expert opinion on truthfulness that admittedly cannot determine whether the response to that SIQ was true or false simply does not carry much weight in determining the truthfulness of the accused’s in-court testimony. Thus, the probative value of the opinion for the proposition offered—the truthfulness of the in-court testimony—is minimal, at best.⁵⁴⁸

The Sixth Circuit agreed that the inability of Dr. Laken to “corroborate Dr. Semrau’s answers as to the particular offenses for which he was charged” was an appropriate factor to consider in assessing the probative value of the evidence.⁵⁴⁹

C. *Probative Value: Reliability*

Opinions based upon scientific principles and methods that are unreliable are inadmissible under Rule 702 irrespective of balancing under Rule 403.⁵⁵⁰ While a threshold level of reliability

underscores the overlap between this aspect of Rule 403 and the “help the trier of fact” element of Rule 702. See *supra* notes 264–330 and accompanying text.

⁵⁴⁸ The Sixth Circuit noted that, “Dr. Laken’s conclusion that Dr. Semrau was ‘not deceptive’ as to the entirety of the alleged criminal conduct is fully consistent with the jury’s determination that he was guilty of only a small part of that conduct.” *United States v. Semrau*, 693 F.3d 510, 524 (6th Cir. 2012).

⁵⁴⁹ *Id.*

⁵⁵⁰ See *supra* notes 335–499 and accompanying text. One commentator argues that when fMRI lie detection technology meets FRE 702’s reliability standard, FRE 403 will not be a barrier to admission. Note, *Weighing the Admissibility of fMRI Technology Under FRE 403: For the Law, fMRI Changes Everything—and Nothing*, 41 FORDHAM URB. L.J. 715, 720 (2013).

is required to meet Rule 702's reliability standard, reliability is a continuum; barely reliable is not the same as unquestionably reliable. The probative value side of the Rule 403 balancing test attempts to place the reliability of a given opinion somewhere along that continuum. The more reliable the principles and methods and the more reliably the expert applied those principles and methods to the question at hand, the greater the probative value of the opinion.

Though not specifically relied upon by the magistrate judge in his Rule 403 balancing in *Semrau*, the Sixth Circuit found that "questions surrounding the reliability of fMRI lie detection tests in general and as performed on Dr. Semrau" also supported exclusion under Rule 403.⁵⁵¹ The court did not specifically assign these concerns to the probative value side of the scale, but it seems rather obvious that doubtful reliability would weaken probative value.

The Sixth Circuit's concern over questions about the general reliability of the principles and methods underlying fMRI as a lie detector and Dr. Laken's application of those to his scan of Dr. Semrau, indicates, however, that Dr. Laken's opinion did not move the probative value side of the Rule 403 scale much at all. As the research continues and the principles and methods are refined and improved, the probative value of an opinion that properly applies those principles and methods should be greater. The Sixth Circuit's reliance on this factor in assessing probative value is not the final word. As the questions that concerned the court are answered, the probative value of an opinion offered in future cases may move the scales. How far will depend upon the validity of the scientific research.

D. *Prejudicial Effect: Bolstering Credibility*

The magistrate judge in *Semrau* also found that expert opinion on lie detection results used "solely to bolster a witness's

⁵⁵¹ Note, *supra* note 550, at 720.

credibility”⁵⁵² was highly prejudicial in a case where credibility was of central importance.⁵⁵³ While this was the second of the three reasons supporting the magistrate judge’s Rule 403 exclusion ruling, it was *not* among the three reasons given by the Sixth Circuit in affirming the Rule 403 exclusion. The Sixth Circuit noted the three reasons the magistrate judge excluded the evidence under Rule 403: (1) the unilateral nature of the test; (2) the sole use of the evidence was to bolster credibility in a case where credibility was a central factor; and (3) the inability of the opinion to address the truth or falsity of specific allegations.⁵⁵⁴ In affirming the exclusion under Rule 403, the Sixth Circuit found no abuse of discretion in light of “(1) the questions surrounding the reliability of fMRI lie detection results in general and as performed on Dr. Semrau, (2) the failure to give the prosecution as opportunity to participate in the testing, and (3) the test result’s inability to corroborate Dr. Semrau’s answers to the particular offenses for which he was charged.”⁵⁵⁵

The appellate court’s omission of any discussion of the prejudicial effect of admitting expert testimony “solely to bolster a witness’s credibility” aligns the Sixth Circuit with those who would reject the continued viability of that argument.⁵⁵⁶ If fact, one could argue that when credibility is of central importance, the probative value of otherwise reliable expert testimony on truthfulness is greater. Other courts would disagree.⁵⁵⁷

E. Prejudicial Effect: Unreliability

Instead of considering the bolstering credibility rationale on the prejudicial effect side of the Rule 403 scale as did the magistrate judge, the Sixth Circuit noted that “questions surrounding the

⁵⁵² United States v. Semrau, No. 07–10074, 2010 WL 6845092, at *14 (W.D. Tenn. June 1, 2010) (citing *Barnier v. Szentmiklosi*, 810 F.2d 594, 597 (6th Cir. 1987)).

⁵⁵³ *Id.*

⁵⁵⁴ United States v. Semrau, 693 F.3d 510, 523 (6th Cir. 2012).

⁵⁵⁵ *Id.* at 524.

⁵⁵⁶ See *supra* note 288.

⁵⁵⁷ See *supra* note 287 (collecting cases).

reliability of fMRI lie detection tests in general and as performed on Dr. Semrau” support exclusion of the evidence under Rule 403. The court did not specify whether the unreliability diminished probative value or increased the prejudicial effect. It actually does both.

Unreliable principles and methods diminish the probative value of an opinion based on those principles and methods for obvious reasons. An opinion based upon scientific principles and methods cannot be any more reliable than the principles and methods themselves. Both the magistrate judge and the Sixth Circuit found fMRI-based opinion on witness truthfulness unreliable when applied to real-world situations involving a sixty-three year-old witness and involving events that transpired some six to eight years before the fMRI scan.⁵⁵⁸ Accordingly, its probative value to prove Dr. Semrau’s truthfulness was minimal.

But because the opinion comes from a respected scientist and is the product of machines that are relied upon for critical medical diagnostic imaging, the jury could assign the opinion more weight than the scientific validity warrants. Accompanied by visual images produced by the MRI scanner and enhanced by computer algorithms to highlight with bright colors areas of the brain where the lie is being processed, the danger of misleading the jury on the appropriate weight the evidence deserves is manifest. The questionable reliability of the opinion lessens its probative value while the risk the jury may give it more weight than its validity warrants increase the prejudicial effect.

F. *Prejudicial Effect: Confusing of the Issues*

Though not specifically addressed by the magistrate judge in *Semrau*, it is readily apparent that the danger of unfair prejudice and jury confusion may be enhanced because of the perceived powerful nature of scientific testimony.⁵⁵⁹ A neuroscientist prepared to show jurors fMRI scan images graphically illustrating

⁵⁵⁸ *United States v. Semrau*, No. 07–10074, 2010 WL 6845092, at *12 n. 17 (W.D. Tenn. June 1, 2010); *Semrau*, 693 F.3d at 522 n.10.

⁵⁵⁹ See *supra* note 299.

the BOLD response in the prefrontal cortex of a trial witness and to explain that those images represented the brain lying and then to show them images without the BOLD response present when the witness was answering truthfully is powerful evidence. This “scientific proof” that a witness was or was not lying could cause the average juror to defer the credibility question to the expert.

To overcome the perceived adverse impact to the government’s case should such evidence be admitted, the prosecution would likely call its own experts to refute the reliability of fMRI methodology and challenging the validity of the defendant’s expert’s opinions. The trial could become a referendum on the reliability of fMRI as a lie detector, and the jury may be distracted from the central issue of the defendant’s guilt or innocence. In *Semrau*, the *Daubert* hearing itself took two days, dozens of exhibits, and three well-qualified experts testifying as to the reliability of fMRI as a truth detector and Dr. Laken’s application of it to Dr. Semrau.⁵⁶⁰ Had the trial court admitted Dr. Laken’s opinion, the substance of the *Daubert* hearing would have been played out before the jury. The jury would then have to weigh the testimony of the various experts and the exhibits to determine what weight to give Dr. Laken’s opinion and then apply that decision to weigh the testimony of Dr. Semrau. Ultimately, the jury would get back to the underlying issue of guilt or innocence, but it would be a rather long and complicated detour taking significant time and requiring considerable concentration and attention on matters collateral to the substantive issues.

VII. RULES OF EVIDENCE: CRIMINAL DEFENDANT’S RIGHT TO OFFER EVIDENCE

Rules of procedure may not arbitrarily deny the criminal defendant the right to present testimony in his own defense. In *Washington v. Texas*,⁵⁶¹ the Court ruled that a Texas statute that precluded co-participants in a crime from testifying for one another

⁵⁶⁰ *United States v. Semrau*, No. 07-10074, 2010 WL 6845092, at *1-4 (W.D. Tenn. June 1, 2010).

⁵⁶¹ 388 U.S. 14 (1967).

violated the defendant's Sixth Amendment right to compulsory process.⁵⁶²

In *Chambers v. Mississippi*,⁵⁶³ the Court held unconstitutional state rules of evidence that prevented the defendant from impeaching his own witness and from introducing hearsay to prove that another person was responsible for the shooting for which he was being tried.⁵⁶⁴ The Court held that in the unique circumstances of the case, excluding persuasive and trustworthy hearsay that was critical to the defense violated Chambers' right to a fair trial. The Court went out of its way, however, to confine the case to its facts and did not "establish . . . new principles of constitutional law."⁵⁶⁵

Similarly, in *Rock v. Arkansas*,⁵⁶⁶ the Court found unconstitutional a *per se* rule that precluded the defendant from testifying in his own defense because he had undergone hypnosis to help him remember the events in question.⁵⁶⁷ The Court held that, "A [state's] legitimate interest in barring unreliable evidence does not extend to *per se* exclusions that may be reliable in an individual case."⁵⁶⁸

Taken together, *Washington*, *Chambers*, and *Rock* might seem to offer some hope for the fMRI-based expert opinion on truthfulness that bolsters the credibility of the defendant. In a case that turns upon whether the jury believes the defendant's or the government's version of the facts, one might argue that rules placing conditions and barriers to bolstering credibility before it has been attacked and requiring rehabilitation evidence to meet the impeaching evidence,⁵⁶⁹ might infringe the defendant's right to a

⁵⁶² *Id.* at 17.

⁵⁶³ 410 U.S. 284 (1973).

⁵⁶⁴ *Id.* at 302–03.

⁵⁶⁵ *Id.* at 302.

⁵⁶⁶ 483 U.S. 44 (1987).

⁵⁶⁷ *Id.* at 62.

⁵⁶⁸ *Id.* at 61.

⁵⁶⁹ See *supra* notes 85–166 and accompanying text for a discussion of the rules governing impeachment and rehabilitation and their application to fMRI-based expert opinion testimony on witness truthfulness.

fair trial. That argument became much less persuasive in 1998 when the Court decided *United States v. Scheffer*.⁵⁷⁰

The issue in *Scheffer* was whether Military Rule of Evidence 707,⁵⁷¹ which imposed a *per se* ban on the admission of polygraph evidence in court-martials, violated the accused's⁵⁷² constitutional right to present a defense.⁵⁷³ Airman Scheffer worked as an informant for the Air Force Office of Special Investigations ("OSI") on drug cases.⁵⁷⁴ As such, he was subject to periodic polygraph examinations and random urinalysis to ensure he was not using drugs.⁵⁷⁵ After a drug test, but before the results were known, Scheffer underwent a polygraph examination administered by an OSI polygrapher.⁵⁷⁶ The test results indicated "no deception" when Scheffer denied using drugs.⁵⁷⁷ Shortly thereafter, Scheffer went AWOL⁵⁷⁸ and was arrested by civilian police during a routine traffic stop approximately two weeks later.⁵⁷⁹ Meanwhile, the results of the urinalysis revealed the presence of methamphetamine.⁵⁸⁰ Scheffer was charged "for uttering bad checks, wrongfully using methamphetamine, failing to go to

⁵⁷⁰ 523 U.S. 303 (1998).

⁵⁷¹ MIL. R. EVID. 707(a) provides: "Notwithstanding any other provision of law, the results of a polygraph examination, the opinion of a polygraph examiner, or any reference to an offer to take, failure to take, or taking of a polygraph examination, shall not be admitted into evidence." The Rule was promulgated by Exec. Order No. 12,767, 56 Fed. Reg. 30,296 (June 27, 1991), pursuant to the President's authority under UCMJ art. 36 to make rules of evidence for military courts.

⁵⁷² In the Military Justice system the criminal defendant is referred to as the "accused." The trial judge is referred to as the "military judge." The jury is referred to as the "members of the court."

⁵⁷³ *Scheffer*, 523 U.S. at 305.

⁵⁷⁴ *Id.*

⁵⁷⁵ *Id.*

⁵⁷⁶ *Id.* at 306.

⁵⁷⁷ *Id.*

⁵⁷⁸ AWOL is the acronym for the military offense of absent without leave, UCMJ art. 86 (2012); 10 U.S.C. § 886 (2012).

⁵⁷⁹ *Scheffer*, 523 U.S. at 306.

⁵⁸⁰ *Id.*

his appointed place of duty, absenting himself from his unit for thirteen days without authority⁵⁸¹

At trial, Scheffer pled not guilty and denied “knowingly” taking any drugs.⁵⁸² To buttress his claim of “innocent ingestion,” Scheffer offered the result of the exculpatory polygraph taken shortly after the urinalysis.⁵⁸³ The military judge, citing Military Rule of Evidence 707, excluded the polygrapher’s opinion testimony.⁵⁸⁴ Scheffer was convicted and appealed to the Air Force Court of Criminal Appeals, which affirmed the military judge’s exclusion of the polygraph evidence.⁵⁸⁵

The Court of Appeals for the Armed Forces granted review and reversed, holding that the *per se* ban of Military Rule of Evidence 707 was unconstitutional in a case where the accused testified at trial, was impeached with inconsistencies between his trial testimony and prior statements, and where the prosecutor argued in closing, “He lies. He is a liar. He lies at every opportunity he gets and he has no credibility.”⁵⁸⁶ Under these circumstances, the court found, a *per se* ban on polygraph evidence deprives the accused of his Sixth Amendment right to present a full defense.⁵⁸⁷

The Supreme Court granted Scheffer’s petition for a writ of certiorari and reversed the Court of Appeals for the Armed Forces, holding 8–1⁵⁸⁸ that the government’s interest in ensuring that reliable evidence is presented in criminal trials was sufficient to justify the *per se* of polygraph testimony.⁵⁸⁹ In light of the lack of a scientific consensus on the reliability of the polygraph and the general exclusion of polygraph evidence by state and federal courts, “excluding polygraph evidence in all military trials [was] a

⁵⁸¹ United States v. Scheffer, 44 M.J. 442, 443 (C.A.A.F. 1996).

⁵⁸² Scheffer, 523 U.S. at 306.

⁵⁸³ *Id.*

⁵⁸⁴ Scheffer, 523 U.S. at 307.

⁵⁸⁵ United States v. Scheffer, 41 M.J. 683 (A.F. Ct. Crim. App. 1995) (en banc).

⁵⁸⁶ United States v. Scheffer, 44 M.J. 442, 444 (C.A.A.F. 1996).

⁵⁸⁷ *Id.* at 445.

⁵⁸⁸ Justices Thomas, Rehnquist, O’Connor, Kennedy, Scalia, Ginsburg, Stevens, Souter, and Breyer were in the majority. Justice Stevens dissented.

⁵⁸⁹ Scheffer, 523 U.S. at 309.

rational and proportional means of advancing the legitimate interest in barring unreliable evidence.”⁵⁹⁰

Four Justices also found that “[p]reserving the court members’ core function of making credibility determinations in criminal trials”⁵⁹¹ and “avoiding litigation over issues other than the guilt or innocence of the accused”⁵⁹² were also legitimate governmental interests that justified the *per se* ban on polygraph evidence.⁵⁹³

As it applies to fMRI-based expert opinion on witness truthfulness, note that *Scheffer* involved a trial where the criminal defendant testified, was impeached, and was specifically accused of lying on the witness stand at trial. The polygraph testimony was offered to rebut the charge of deliberate fabrication of trial testimony. Because eight justices found that polygraph evidence was unreliable and that unreliability justified the Commander-in-Chief’s *per se* ban on all polygraph evidence, *Scheffer*’s Sixth Amendment argument failed. As noted in Part IV.C of this Article, this is one of the scenarios in which traditional rules of impeachment and rehabilitation would countenance extrinsic evidence to bolster credibility. Should fMRI lie detection technology reach a level of reliability to satisfy Rule 702, exclusion of opinion testimony in this situation would, arguably, violate the Sixth Amendment rights of the defendant. Short of reaching that level of reliability, or if the offer of fMRI-based opinion to bolster credibility does not come after the defendant has testified and been impeached with an express or implied charge of deliberate in-court fabrication, *Scheffer* is distinguishable and would not directly support the constitutional argument to admit the evidence.

Assuming no significant advances in fMRI lie detection reliability, courts rejecting Sixth Amendment arguments for admission would seem to be on solid ground. Of course, should fMRI lie detection become more reliable, or if polygraph itself demonstrates significant

⁵⁹⁰ *Id.* at 312.

⁵⁹¹ *Id.* at 312–13.

⁵⁹² *Id.* at 314.

⁵⁹³ *Id.* at 314–15.

improvement in reliability, the Sixth Amendment argument would gain new strength in the circumstances of *Scheffer*. While *Scheffer* stands for the proposition that the Sixth Amendment does not provide a right to introduce unreliable evidence, it does not determine the reliability question for all time.

VIII. CONCLUSION

Functional magnetic resonance imaging as a lie detector is, relatively speaking, in its infancy. Its ultimate acceptance by the courts as a reliable indicator of credibility will require considerable advances in the science underlying the theory as well as considerable changes in attitudes of the judicial system towards the jury's role in determining credibility issues.

A number of scientific shortcomings must be resolved before fMRI can satisfy the exacting standards of admissibility in American trials. First, is the lack of any real world testing of fMRI's reliability as a lie detector. The studies done to date have all been laboratory controlled experiments where subjects were paid to lie about certain recent events while undergoing fMRI scanning. We do not know and can only assume that the neural correlates of these "instructed lies" are the same as lies told in the "real world." While laboratory experiments and tests are instrumental in scientific advancements, they do not and cannot duplicate the range of human emotions and responses one experiences when faced with accusations of wrongdoing in the real world. Unless and until fMRI proves its reliability as a lie detector in real world applications, it will remain an interesting area of scientific inquiry that may well lead to a better understanding of brain function that will have other benefits to society.

Second, is the inability of the fMRI to distinguish between the subjective belief of the witness and objective truth. During cross-examination of Dr. Laken at the *Daubert* hearing in *Semrau*, the following exchange took place:

Q: You have not performed any fMRI testing in a situation such as we have here where an individual has been living with an alleged lie or a potential lie for a period of six to eight years, correct?

A: So we tested and our conclusions are based on today, what does he believe today.

Q: But whether or not the effect of the memory or the fusing of that lie into the person's brain, whether or not that is possible, you don't know because you haven't researched it.

A: We don't know.⁵⁹⁴

Similarly, during direct examination, Dr. Laken testified that the fMRI scan showed that "[Dr. Semrau] believes that he is telling the truth at least."⁵⁹⁵ Whether the witness believes he is telling the truth is not the question the jury must decide. The jury has to determine whether the witness is *actually* telling the truth. According to Dr. Laken, perhaps the country's foremost proponent of fMRI as lie detector or truth verifier, the technology is incapable of making that critical distinction.

Third is the lack of protocols or standards, specifically with regard to SIQ formulation, scanning procedures, and the computer processes necessary to convert the raw data to the final image reflecting the BOLD response. Dr. Laken concluded, without any research to support it, that the form of the questions during the first scan on the AIMS testing were in some way responsible for the initial deception determination. By revising the SIQs and rescanning, he obtained a truthful result. If the outcome can be so dramatically altered by reformatting the SIQs it would seem that appropriately designed studies would identify the critical components of SIQ formulations and standard protocols developed. Until then it appears that the person conducting the test can redraft SIQs and rescan until the desired result is obtained.

Even if fMRI's proponents can establish reliability in real world applications, there is still the well-recognized and almost sacred principle that the jury is responsible for determining the credibility of the witnesses at trial, and they do not need the assistance of expert opinion in performing that task. The average juror, as a citizen going through daily life makes credibility judgments about other people all the time. Sometimes they judge

⁵⁹⁴ Testimony of Steven Laken, Transcript of Proceedings, Vol. II at 221–22, *United States v. Semrau*, No. 07CR10074-1JPM, 2010 WL 6845092 (W.D. Tenn. May 13, 2010).

⁵⁹⁵ *Id.* at 99.

rightly and sometimes they judge wrongly. Our judicial system expects those citizens to bring those experiences and that common sense into the jury box and apply them to the witnesses who testify at trial. But the American system of justice does not entrust that duty to a single person.⁵⁹⁶ The jury, as a group of citizens, must reach a collective judgment on who to believe and what weight to give the testimony of the witnesses at trial. In the criminal trial, the jury of twelve citizens⁵⁹⁷ stands as the bulwark between the power of the state and the freedom of the defendant. This citizen's check on the power of the state is deeply entrenched in the American understanding of democracy and the people's relationship with the state. Conceding that role to MRI scanners and expert witnesses with scientific opinions on who is and who is not telling the truth is a radical departure from our common law heritage and the very basis of the jury system.

Compounding these problems is the reality that under the current rules and traditions of impeachment and rehabilitation, the use of extrinsic evidence in the form of expert opinion testimony on witness truthfulness is available only in a limited number of circumstances. Those circumstances are further limited by the fact that opportunities to offer fMRI-based expert opinion on truthfulness will depend upon the trial tactics of the opposing party; something the proponent of the expert testimony cannot control. Whether commercially viable lie detection will be available at prices litigants can afford when the opportunity for actually admitting the evidence at trial is remote is a problem. The time, effort, and expense of the neuroscience community to study "real world" application of the technology when its actual use at trial is rather remote may stifle the research. One company which

⁵⁹⁶ Of course, a defendant may waive the right to a jury trial and elect to have a single individual, the trial judge, decide his fate.

⁵⁹⁷ Some jurisdictions try cases with six jurors, but the tradition and usual practice is to empanel twelve.

had offered fMRI lie detection services, Cephos Corporation, has already abandoned the market.⁵⁹⁸

While fMRI may hold great promise in neuroscience and eventually bring new understanding to human behavior, its use as a lie detector in American courts is stymied by the law of expert testimony under both the *Daubert* and *Frye* standards, the problem of creating jury confusion over the collateral issue of witness credibility, the tradition against bolstering witness credibility before it has been attacked, and the common law tradition of placing credibility determinations solely within the province of the jury. Separately, these evidentiary hurdles present significant challenges to the admissibility of fMRI based expert opinion testimony of witness truthfulness. Combined, they present a virtually insurmountable barrier.

The advance of science and the tenaciousness of the neuroscience community may well solve the reliability issue that precludes admissibility under *Daubert* and *Frye*. Addressing the other barriers to admissibility will fall within the purview of the legal community. That debate is ongoing and will continue unabated.

⁵⁹⁸ Cephos Corporation, the company providing the fMRI services in *Semrau* and *Wilson*, left the lie detection market in 2013. Apparently the time, effort, and expense to develop the technology to a point where it would meet admissibility standards was not commercially feasible. See *supra* note 194.

NORTH CAROLINA JOURNAL OF LAW & TECHNOLOGY

**VOLUME 16, ISSUE 2
JANUARY 2015**

Published by:



University of North Carolina School of Law
Chapel Hill, North Carolina

COPYRIGHT POLICY

Permission to make digital or hard copies of part or all of this work for personal or classroom use is granted without fee provided that copies are not made or distributed for profit or commercial advantage and that copies bear this notice and the full citation on the first page. Copyrights for components of this work owned by others than the *North Carolina Journal of Law & Technology* must be honored; copyright to each article is owned by its respective author(s). Abstracting with credit is permitted. To copy otherwise, to republish, to post on servers, or to redistribute to lists requires prior specific permission and/or a fee. To request permission, e-mail info@ncjolt.org, contact the Editor-in-Chief at the below mailing address, or contact the author of the article.

Copyright © 2014, North Carolina Journal of Law & Technology.
All rights reserved.

SUBSCRIPTIONS AND BACK ISSUES

The *North Carolina Journal of Law & Technology* publishes four issues per volume: two in the Fall and two in the Spring. Annual subscriptions are \$40 for the complete volume. For more information or to subscribe, visit ncjolt.org, e-mail info@ncjolt.org, or contact the Managing Editor at the following address:

North Carolina Journal of Law & Technology
University of North Carolina School of Law
Van Hecke-Wettach Hall
160 Ridge Road, CB #3380
Chapel Hill, North Carolina 27599-3380

Articles are available online at ncjolt.org and through Lexis-Nexis, Westlaw, and Hein Online subscription services. Back issues and complete sets of the *North Carolina Journal of Law & Technology* may be ordered directly from William S. Hein & Co., 1285 Main Street, Buffalo, New York 14209-1987. Orders may also be placed by calling Hein at (800)-828-7571, via fax at (716)-883-8100, or e-mail to order@wshein.com.

PUBLICATION INFORMATION

The text and citations of the *North Carolina Journal of Law & Technology* conform to *The Bluebook: A Uniform System of Citation* (19th ed. 2010). Materials cited “on file with the North Carolina Journal of Law & Technology” will be retained for a maximum of five years from date of publication. The journal is printed by Joe Christensen, Inc. in Lincoln, Nebraska. Publication number ISSN: 1542-5177.

SPONSORS

The *North Carolina Journal of Law & Technology* would like to thank the generous contributors who have helped make this journal possible:

Benefactors:



The University of
North Carolina at Chapel Hill
Student Congress

Anne Klienfelter, Associate Professor of Law and Director of the
Law Library, UNC School of Law

Patrons:



UNC
GRADUATE *and* PROFESSIONAL
STUDENT FEDERATION

UNC
CENTER FOR
MEDIA LAW &
POLICY

This publication is funded in part by Student Fees that were appropriated and disbursed by the Student Government at University of North Carolina at Chapel Hill and the Student Bar Association of the University of North Carolina School of Law.

BOARD OF ADVISORS

CASSIE ANDERSON—Greenberg Traurig LLP; *N.C. JOLT* Editor-in-Chief, Vol. 12

HOLLY BANNERMAN—MJM Group; *N.C. JOLT* Editor-in-Chief, Vol. 15

ANDREW CHIN—Associate Professor of Law, UNC School of Law

AARON R. HARMON—Clinical Assistant Professor of Law, UNC School of Law;
N.C. JOLT Editor-in-Chief, Vol. 8; *N.C. JOLT* Faculty Advisor

ANNE KLINEFELTER—Associate Professor of Law and Director of the Law
Library, UNC School of Law; *N.C. JOLT* Faculty Advisor

MARY U. MUSACCHIA—First Flight Venture Center, Inc. & Whitmeyer Tuffin,
PLLC; Original Board Member

ANDREW SALEK-RAHAM—Groom Law Group; *N.C. JOLT* Editor-in-Chief, Vol. 14

RANDY WHITMEYER—Whitmeyer Tuffin PLLC; *N.C. JOLT* Board Member

KIM WIERZEL—Patterson + Sheridan, LLP

ALAN E. WROBEL—Managing Attorney, SAS Institute Inc; Original Board
Member

VOLUME 16, 2014–2015

EDITOR-IN-CHIEF

KYLE EVANS

EXECUTIVE EDITORS

KELLY MORRIS
NICHOLAS TURZA

MANAGING EDITOR

CATHERINE PEREZ

WEB EDITOR

WILL BLACKTON

PUBLICATION EDITORS

TONY LUCAS
BEN SZANY

SYMPOSIUM EDITOR

AMELIA SERRAT

SENIOR ARTICLES EDITOR

RYAN NILAND

ARTICLES EDITORS

KERRY BOEHM
MATTHEW HENRY
GABE KUSSIN

DANIEL PARISI
CHRISTINA WHEATON

NOTES EDITORS

KETA DESAI
RORY FLEMING
BRITTON LEWIS

JENNIFER NUSBAUM
MATTHEW SPANGLER

STAFF MEMBERS

KINNARI BHOJANI
COREY BROWN
DANIEL BURKE
ERIN CARTER
KEVIN CLEYS
COLLETTE CORSER
ALEXANDER COVINGTON
CHARLOTTE DAVIS
HILLARY DAWE
PRESTON DOLE

MATTHEW FARR
ROBERT GLOWACKI
JASON GREEN
CARMEN HAITHCOCK
CALINE HOU
MA'IDAH LASHANI
ADAM MAAS
CARMELA MASTRIANNI
MARIA MOORE
CAMERON NEAL

RICHARD PEPPER
JAMES POTTS
SHAYAAN RAJA
JOSEPH SHUFORD
MARY SIMPSON
KYLIE SPANGLER
CHRYSTAL TOMBLYN
SETH WALKER
CHELSEA WEIERMILLER

