

Serendipitous Timing: The Coincidental Emergence of the New Brain Science and the Advent of an Epistemological Approach to Determining the Admissibility of Expert Testimony

by Edward J. Imwinkelried*

“Mind is the great leveler of all things.”

–Daniel Webster¹

This is an exciting time for students of the human brain. Worldwide there has never been such intense interest in and extensive research into the brain. Techniques for studying the brain are proliferating. By way of example, one group of scientists is employing electroencephalography (EEG) as a tool to investigate the brain's operations.² Some of these researchers have utilized EEG to identify brain damage; others, including Dr. Lawrence Farwell of Brain Fingerprinting Laboratories, are endeavoring to adapt EEG technology to the detection of deception.³ Another group of scientists has focused its research on BOLD fMRI (Blood Oxygen Level Dependent functional Magnetic Resonance

* Edward L. Barrett, Jr. Professor of Law, University of California Davis School of Law. University of San Francisco (B.A., 1967; J.D., 1969).

1. DANIEL WEBSTER, THE BUNKER HILL MONUMENT ORATIONS 22 (Albert F. Blaisdell ed., Clark & Maynard 1885).

2. FUNDAMENTAL NEUROSCIENCE 1389 (Michael Zigmond et al. eds. 1999).

3. See, e.g., BRAIN FINGERPRINTING LABORATORIES, www.brainwavescience.com/About-Farwell.php (last visited Feb. 10, 2011).

Imaging).⁴ Some researchers at Washington University have adapted the technique to identify the verbal center of patients' brains.⁵ As in the case of EEG, others, notably Cephos Corporation⁶ and No-Lie MRI,⁷ are using fMRI as a type of lie detector. The volume of literature in the area is growing exponentially. At the beginning of this century, there were already several published research studies on fMRI alone.⁸ The forthcoming third edition of the Federal Judicial Center's *Reference Manual on Scientific Evidence* will include a chapter devoted to the brain sciences.⁹

Although the mention of the courtroom use of brain science understandably brings to mind the possibility of introducing testimony based on such science, the courtroom impact of brain science will not be limited to its evidentiary use. The rules of evidence come into play when a litigator uses information for an adjudicative purpose, that is, to help a trier of fact decide the historical facts of the instant case.¹⁰ If the litigator proffers brain science data to help the trier determine the who, what, which, when, where, and why of the pending case, the litigator obviously must comply with formal evidentiary rules such as the limitations on expert opinion testimony. The third part of this article discusses several adjudicative uses of brain science data.

However, a litigator may put brain science information to other, very different uses. For instance, the litigator may proffer the information for the legislative or normative purpose of persuading the judge to formulate

4. See generally RICHARD B. BUXTON, INTRODUCTION TO FUNCTIONAL MAGNETIC RESONANCE IMAGING PRINCIPLES AND TECHNIQUES (2002); SCOTT A. HUETTEL ET AL., FUNCTIONAL MAGNETIC RESONANCE IMAGING (2004).

5. Gerry Everding, *Better Imaging Helps Surgeons Avoid Damage to Language Functions*, NEWSROOM, WASHINGTON UNIVERSITY ST. LOUIS, Nov. 4, 2003, <http://news.wustl.edu/news/Pages/494.aspx>.

6. CEPHOS CORP., <http://www.cephoscorp.com> (last visited Feb. 10, 2011).

7. NO LIE MRI, INC., <http://noliemri.com> (last visited Feb. 10, 2011).

8. For a listing of some of these studies, see Kathleen M. O'Craven & Nancy Kanwisher, *Mental Imagery of Faces and Places Activates Corresponding Stimulus-Specific Brain Regions*, 12 J. COG. NEUROSCIENCE 1013 (2000).

9. The third edition of the *Reference Manual on Scientific Evidence* is expected to be issued in 2011. See COMM. ON SCIENCE, TECH., AND LAW, THE NAT'L ACADEMICS, http://sites.nationalacademies.org/pga/stl/development_manual/index.htm (last visited Feb. 10, 2011).

10. See FED. R. EVID. 201 Advisory Committee's Note; Kenneth Culp Davis, *A System of Judicial Notice Based on Fairness and Convenience*, in PERSPECTIVES OF LAW: ESSAYS FOR AUSTIN WAKEMAN SCOTT 69, 87 (Roscoe Pound et al. eds. 1964) [hereinafter Davis, *A System*]; Kenneth Culp Davis, *An Approach to Problems of Evidence in Administrative Process*, 55 HARV. L. REV. 364, 404 (1942) [hereinafter Davis, *An Approach*]; Edward J. Imwinkelried, *Expert Testimony by Ethicists: What Should Be the Norm?*, 76 TEMP. L. REV. 91, 114-18 (2003).

a common-law rule,¹¹ determine the proper construction of a statute,¹² or frame a constitutional doctrine.¹³ When the litigator puts information to a normative use, the formal rules of evidence are inapposite.¹⁴ As James Bradley Thayer famously put it, the formal rules are “the child of the jury system;”¹⁵ the common law developed the rules to compensate for lay jurors’ supposed deficiencies in critically evaluating evidence. Those policy concerns are inapplicable when the decision-maker is the judge rather than the jury. If a judge is performing an essentially legislative function, the technical evidentiary rules should not constrain his or her ability to gather and consider relevant information.¹⁶

In her presentation at this Symposium, Professor Susan Bandes discussed the propriety of imposing criminal responsibility for negligent conduct.¹⁷ As she noted, some commentators have argued that criminal sanctions ought to be imposed only for conduct involving “conscious choice.” She argued that modern brain science undermines any simplistic distinction between the conscious and the subconscious. More specifically, she contended that to an extent persons can access their subconscious and that consequently, the imposition of criminal sanctions could influence and deter even negligent behavior.¹⁸ A litigator pressing this argument on a judge would clearly be using brain science data for a normative or legislative purpose and hence would not have to comply with formal evidentiary strictures.

Those strictures, though, are the focus of this Article. This Article deals with the adjudicative use of brain science data. At the same time that the scientific community is concentrating more attention on brain science, the legal community has been fashioning a new approach to determining the admissibility of expert testimony, including testimony based on the latest theories and techniques being developed by brain scientists. In 1923 the United States Court of Appeals for the District of Columbia Circuit rendered its famous decision in *Frye v. United States*.¹⁹ The court in *Frye* announced that to introduce testimony

11. See Davis, *A System*, *supra* note 10, at 87.

12. See *id.*; see also 2 KENNETH C. DAVIS & RICHARD J. PIERCE, JR., ADMINISTRATIVE LAW TREATISE § 10.6, at 154 (3d ed. 1994).

13. Davis, *A System*, *supra* note 10, at 87; Davis, *An Approach*, *supra* note 10, at 404.

14. Imwinkelried, *supra* note 10, at 114-27.

15. FED. R. EVID. 104 Advisory Committee’s Note.

16. See *id.*; Imwinkelried, *supra* note 10, at 114-18.

17. *The Brain Sciences in the Courtroom*, *A Symposium of the Mercer Law Review*, 62 MERCER L. REV. 769, 811 (2011) (Susan Bandes’s title in the Symposium program was *The Implications of Neuroscience for Criminal Negligence Liability*).

18. *Id.* at 815-17.

19. 293 F. 1013 (D.C. Cir. 1923).

based on a scientific theory or technique, the proponent had to lay a foundation establishing that the theory or technique had “gained general acceptance in the particular field in which it belongs.”²⁰ Over the course of the next half century, the general acceptance test evolved into the overwhelming majority view in the United States.²¹ By the mid-1970s the *Frye* test had become the governing standard in federal court as well as in forty-five states.²²

However, in 1993 in *Daubert v. Merrell Dow Pharmaceuticals, Inc.*,²³ the Supreme Court of the United States ruled that the general acceptance test was no longer good law in federal court.²⁴ The Court reasoned that the enactment of the Federal Rules of Evidence in 1975 has impliedly overturned *Frye*.²⁵ The Court stated that the text of Rule 402²⁶ had the effect of abolishing uncodified common-law exclusionary rules of evidence.²⁷ Writing for the majority, Justice Blackmun professed that he could not find any statutory language that could reasonably bear the interpretation that it preserved a general acceptance test; instead, the Justice derived a new, empirical validation test from the text of Rule 702.²⁸ That rule refers to expert testimony based on “scientific, technical, or other specialized knowledge.”²⁹ Drawing on several amicus briefs submitted by scientists and scientific organizations, the Justice adopted a methodological definition of the expression, “scientific . . . knowledge.”³⁰ The proponent must show that the theory or technique qualifies as “reliable” scientific knowledge.³¹ The decisive question is whether the proponent has demonstrated that the expert’s theory or technique has been empirically validated, that is, whether it

20. *Id.* at 1014.

21. 1 PAUL C. GIANNELLI & EDWARD J. IMWINKELRIED, SCIENTIFIC EVIDENCE § 1.06, at 13 (4th ed. 2007).

22. Betty R. Steingass, Comment, *Changing the Standard for the Admissibility of Novel Scientific Evidence: State v. Williams*, 40 OHIO ST. L.J. 757, 769 (1979).

23. 509 U.S. 579 (1993).

24. *Id.* at 597.

25. See *Daubert*, 509 U.S. at 597; see also FED. R. EVID. 702.

26. FED. R. EVID. 402 (“All relevant evidence is admissible, except as otherwise provided by the Constitution of the United States, by Act of Congress, by these rules, or by other rules prescribed by the Supreme Court pursuant to statutory authority.”).

27. See *Daubert*, 509 U.S. at 587-88; Edward J. Imwinkelried, *Federal Rule of Evidence 402: The Second Revolution*, 6 REV. LITIG. 129, 129 (1987).

28. See *Daubert*, 509 U.S. at 588-92.

29. FED. R. EVID. 702.

30. *Daubert*, 509 U.S. at 589-90; Edward J. Imwinkelried, *The Daubert Decision: Frye Is Dead, Long Live the Federal Rules of Evidence*, 29 TRIAL, Sept. 1993, at 60, 62-63 (internal quotation marks omitted).

31. *Daubert*, 509 U.S. at 590.

is supported by adequate, methodologically sound empirical data.³² Justice Blackmun listed several factors that trial judges could consider in evaluating the reliability of the proffered testimony, but he also stressed that “[t]he inquiry envisioned by Rule 702 is . . . a flexible one.”³³

The Supreme Court struck a similar note in 1997 in *General Electric Co. v. Joiner*³⁴ when it held that the trial judge enjoys considerable discretion in applying the *Daubert* factors to assess the reliability of the testimony.³⁵ Finally, in 1999 the Court completed its trilogy of expert testimony decisions. In that year the Court handed down its decision in *Kumho Tire Co. v. Carmichael*.³⁶ In *Kumho* the Court addressed the admissibility of testimony based on nonscientific expertise.³⁷ On the one hand, acknowledging that square pegs do not fit into round holes, the Court conceded that some of the factors listed in *Daubert* might be inappropriate for gauging the admissibility of nonscientific expert testimony.³⁸ On the other hand, the Court insisted that regardless of the species of expertise, the proponent of any expert testimony must demonstrate its reliability.³⁹ According to the Court, the term “knowledge” in Rule 702 is the source of the requirement for a showing of reliability.⁴⁰ Whenever the proponent proffers expert testimony, the proponent must demonstrate that the testimony rests on more than the witness’s ipse dixit claim that his or her theory or technique is trustworthy.⁴¹

The thesis of this Article is that it is serendipity that the courts have developed this new approach to determining the admissibility of expert testimony at roughly the same time that brain science is entering a new era. The Article develops that thesis in three steps.

The first part of the Article describes the prior state of the law under the *Frye* regime. This part argues that the general acceptance test is a flawed approach to assessing the admissibility of expert testimony. At best, general acceptance is a crude proxy for what should matter most to the law, namely, whether by employing the theory or technique the expert can accurately draw the inference he or she proposes testifying

32. *Id.* at 592-93.

33. *Id.* at 593-95.

34. 522 U.S. 136 (1997).

35. *See id.* at 146.

36. 526 U.S. 137 (1999).

37. *Id.* at 141.

38. *Id.* at 150.

39. *See id.* at 152.

40. *Id.* at 147.

41. *Id.* at 157.

to. Further, most *Frye* jurisdictions recognized broad, amorphous exemptions from the test for various types of expertise such as “soft science.” Consequently, the courts admitted many kinds of expertise without subjecting the testimony to any meaningful scrutiny. If the witness qualified as an expert⁴² and the subject was beyond the ken of the average layperson,⁴³ the judge did not scrutinize the underlying theory or technique. The *Frye* jurisprudence would be an inept framework for separating the wheat from the chaff in the new brain sciences.

The second part of the Article contrasts the analytic framework that is emerging in the *Daubert-Joiner-Kumho* line of authority. As we shall see, at root this framework is an epistemological approach that requires the trial judge to evaluate the warrant for the expert’s knowledge claim. This part attempts to synthesize the case law by arguing that to properly apply this framework, the trial judge must address three questions. The first question is *which* theory or technique; initially, the judge must identify the specific theory or technique that the expert contemplates utilizing. The question is not the global validity of the expert’s discipline. The next question is *why* the proponent is offering the testimony about the theory or technique: What is the specific use that the expert is putting the technique to? Once the proponent has answered the *which* and *why* questions to the judge’s satisfaction, the judge can reach the ultimate issue: *How* should the proponent validate that particular use of that theory or technique? In effect, the answers to the *which* and *why* questions specify the hypothesis to be tested. The judge then inquires whether the proponent has marshaled enough methodologically sound empirical data to validate the hypothesis—an essentially epistemological test. This part of the Article applies this three-step framework to several types of expertise to demonstrate the utility of the framework.

More to the point of this Symposium, the third part of the Article turns to the question of whether this new analytic framework can be used effectively to make sensible decisions about the admissibility of testimony based on the emerging brain sciences. This part draws on the literature on EEG and BOLD fMRI to illustrate that the framework is sufficiently flexible and powerful to help the courts resolve the admissibility issues posed by advances in brain science.

42. FED. R. EVID. 702 (“a witness qualified as an expert by knowledge, skill, experience, training, or education”).

43. *Id.* (“assist the trier of fact to understand the evidence or . . . determine a fact in issue”).

I. *FRYE'S* FLAWED APPROACH TO DETERMINING THE ADMISSIBILITY OF
EXPERT TESTIMONY

A. *General Acceptance as a Proxy for Reliability*

*Frye v. United States*⁴⁴ is a remarkable opinion. The opinion consists of only two pages, and in those two pages the court neither cited authority nor advanced any policy rationale for the general acceptance test it enunciated.⁴⁵ Of course, the common law has a tremendous capacity for post hoc rationalization. Several courts that later adopted *Frye* demonstrated that capacity by proposing a rationale for the original decision in *Frye*. The California courts defended the rationale that the trial judge ought to confine his or her inquiry to determining whether the theory was generally accepted because, as a layperson, the judge was incompetent to resolve a true battle between scientists. The same courts expressed skepticism about the jury's capacity to critically evaluate scientific testimony.⁴⁶

The *Frye* test did not merely counsel general deference to the scientific community. Rather, it amounted to a formal delegation of the admissibility decision to that community. In *United States v. Addison*,⁴⁷ a 1974 decision by the Court of Appeals for the District of Columbia Circuit, the court declared "[t]he requirement of general acceptance in

44. 293 F. 1013 (D.C. Cir. 1923).

45. GIANNELLI & IMWINKELRIED, *supra* note 21, § 1.06, at 13. See generally Paul C. Giannelli, *The Admissibility of Novel Scientific Evidence: Frye v. United States, A Half-Century Later*, 80 COLUM. L. REV. 1197 (1980).

46. See generally *People v. Kelly*, 549 P.2d 1240 (Cal. 1976). To say the least, the assumption of juror and judicial incompetence is debatable. In truth, the assumption is at odds with most of the empirical investigations conducted to date. A 1989 survey article concluded that "[t]he image of a spellbound jury mesmerized by . . . a forensic expert is more likely to reflect . . . fantasies than the . . . realities of courtroom testimony." Richard Rogers & Charles Patrick Ewing, *Ultimate Opinion Proscriptions: A Cosmetic Fix and a Plea for Empiricism*, 13 L. & HUM. BEHAV. 357, 363 (1989). The most comprehensive collection of the empirical data is probably the Brief for Neil Vidmar et al. as Amici Curiae Supporting Respondents, *Kumho Tire Co. v. Carmichael*, 526 U.S. 137 (1999) (No. 97-1709), 1998 WL 734434. After surveying the available studies, the brief concludes:

The Supreme Court's decision in this case should not be based on the Petitioners' unsupported or flawed assertions that juries fail to critically evaluate expert testimony, that they are overawed by experts, [or] that they have a "natural tendency" to defer to experts[.] The heavy preponderance of data from more than a quarter century of empirical jury research points to just the opposite view of jury behavior.

Brief for Neil Vidmar et al., at 25.

47. 498 F.2d 741 (D.C. Cir. 1974).

the scientific community assures that those most qualified to assess the general validity of a scientific method will have the determinative voice.”⁴⁸ In the same vein, in 1977 the Michigan Supreme Court decided to continue to adhere to *Frye*.⁴⁹ The court explained that under *Frye*, the members of the relevant scientific specialities “[i]n effect . . . form a kind of technical jury, which must first pass on the scientific status of a [theory or technique]” before the jury can be exposed to the theory or technique.⁵⁰

The crux of the *Frye* approach was treating general acceptance as a proxy or surrogate for the validity of the scientific theory or technique.⁵¹ However, the popularity of a theory does not guarantee its scientific validity.⁵² As Thomas Kuhn convincingly documented,⁵³ the history of science is replete with examples of dominant paradigms that were shattered by later empirical research. Nor does the novelty of a theory—fatal to admissibility under *Frye*—dictate the conclusion that the theory or technique is invalid. In many instances, again by virtue of meticulous empirical research, “yesterday’s [scientific] heresy becom[es] tomorrow’s conventional wisdom.”⁵⁴ Ultimately, it became evident that general acceptance was a failed, crude proxy for scientific validity and accuracy.⁵⁵ In rejecting *Frye*, the Georgia Supreme Court wrote disparagingly that the general acceptance test was reducible to “counting

48. *Id.* at 743-44.

49. *People v. Barbara*, 255 N.W.2d 171, 194-95 (Mich. 1977).

50. *Id.* at 194.

51. Bert Black et al., *Science and the Law in the Wake of Daubert: A New Search for Scientific Knowledge*, 72 TEX. L. REV. 715, 725 (1994). The distinguished physicist, Richard Feynman, has observed:

When someone says, “Science teaches such and such,” he is using the word incorrectly. Science doesn’t teach anything; experience teaches it. If they say to you, “Science has shown such and such,” you [should] ask, “How does science show it? How did the scientists find out? How? What? Where?” . . . And you have as much right as anyone else, upon hearing about the experiments (but be patient and listen to all the evidence) to judge whether a sensible conclusion has been arrived at.

Richard Feynman, *What Is Science?*, 7 PHYSICS TEACHER 313, 320 (1969) (emphasis omitted).

52. See Edward J. Imwinkelried, *Evidence Law Visits Jurassic Park: The Far-Reaching Implication of the Daubert Court’s Recognition of the Uncertainty of the Scientific Enterprise*, 81 IOWA L. REV. 55, 60 (1995).

53. See generally THOMAS S. KUHN, *THE STRUCTURE OF SCIENTIFIC REVOLUTIONS* (2d ed. 1970).

54. Brief for Physicians, Scientists, and Historians of Science as Amici Curiae Supporting Petitioners at 15, *Daubert v. Merrell Dow Pharmaceuticals* (1992) (No. 92-102), 1992 WL 12006437.

55. Black, *supra* note 51, at 725.

heads.”⁵⁶ The validity of a theory should be determined by what happens in a research laboratory, not by a show of hands at a scientific convention.

B. The Exemptions from the Scope of the General Acceptance Test for Soft Science and Nonscientific Expertise

There are not only grave concerns about the wisdom of using general acceptance as the litmus test for admissibility; there are also serious questions about the scope of the test. Perhaps in part because of nagging doubts about the wisdom of the test, many *Frye* jurisdictions have carved out exceptions to the test’s ambit.⁵⁷ For instance, although the California Supreme Court has vigorously championed *Frye*, in *People v. McDonald*⁵⁸ the same court adamantly refused to apply *Frye* to psychological testimony about the supposed unreliability of eyewitness identifications.⁵⁹ The court acknowledged that it subscribed to *Frye* out of a belief that lay “jurors tend to ascribe an inordinately high degree of certainty” to scientific testimony.⁶⁰ However, the court stated that the risk of jury overvaluation is a significant concern only when the purported scientific “evidence is produced by a machine.”⁶¹ The court observed, “We have never applied the . . . *Frye* rule to expert medical testimony, even when the witness is a psychiatrist and the subject matter is as esoteric as the reconstitution of a past state of mind or the prediction of future dangerousness[.]”⁶² In another case, the same California court proclaimed that *Frye* applies only to “the direct product of a mechanical device such as a lie detector.”⁶³ This limitation, restricting *Frye* to instrumental scientific techniques, has a wide following.⁶⁴ “[M]any courts” embraced that restriction,⁶⁵ and there

56. Harper v. State, 249 Ga. 519, 525, 292 S.E.2d 389, 395 (1982).

57. Edward J. Imwinkelried, *Attempts to Limit the Scope of the Frye Standard for the Admission of Scientific Evidence: Confronting the Real Cost of the General Acceptance Test*, 10 BEHAV. SCI. & L. 441, 446-48 (1992).

58. 690 P.2d 709 (Cal. 1984).

59. *Id.* at 723-24.

60. *Id.* at 724.

61. *Id.*

62. *Id.*

63. People v. Shirley, 723 P.2d 1354, 1368 (Cal. 1982).

64. See generally People v. Hampton, 746 P.2d 947 (Colo. 1987); State v. Oslund, 469 N.W.2d 489, 494-95 (Minn. App. 1991); State v. Young, 802 P.2d 829, 836 (Wash. App. 1991) (an expert’s “clinical findings”); Linda Robertson, *The Kelly-Frye Rule*, 4 CALIF. DEFENDER 50, 51 (1990-1991) (listing techniques which the California courts have indicated are “not subject to” the *Frye* rule); Ralph Slovenko, *Syndrome Evidence in Establishing a Stressor*, 12 J. PSYCHIATRY & L. 443, 465 n.23 (1984) (the *Frye* rule “at times [is] not applied to the testimony of medical experts or psychologists”).

was a discernible trend toward “narrowing *Frye*’s applicability.”⁶⁶ One relatively comprehensive survey of *Frye* case law concluded that this restriction was “[t]he majority view.”⁶⁷

Even more fundamentally, most *Frye* jurisdictions apply the test only to purportedly scientific testimony. Prior to *Daubert v. Merrell Dow Pharmaceuticals, Inc.*⁶⁸ and *Kumho Tire Co. v. Carmichael*,⁶⁹ doubts about the reliability of nonscientific expert testimony went “largely unregarded” by the courts.⁷⁰ Most jurisdictions balked at applying *Frye* to nonscientific expert testimony.⁷¹ The courts adopted a virtually laissez-faire attitude toward the reliability of propositions underlying nonscientific expert testimony.⁷² As in the case of soft science, the courts demanded a twofold foundational showing that the witness qualifies as an expert and that the testimony would be helpful to the trier of fact.⁷³ However, beyond that minimal showing, the courts tended to uncritically accept a nonscientific expert’s claim that the proposition he or she proposes testifying to is reliable.⁷⁴ For the most part, the courts failed to enforce any objective,⁷⁵ articulable⁷⁶ standards to determine the admissibility of opinions based on nonscientific expertise. In a recent case, the California Supreme Court bypassed the opportunity to modify or clarify the breadth of that state’s exemption for nonscientific testimony.⁷⁷

Like the general acceptance test itself, these exemptions were of dubious wisdom. The proponents of the exemptions sometimes defended

65. 2 GREGORY P. JOSEPH & STEPHEN A. SALTZBURG, EVIDENCE IN AMERICA: THE FEDERAL RULES IN THE STATES § 51.5, at 21 (1987).

66. *Id.* at 23; see *People v. Cegers*, 9 Cal. Rptr. 2d 297 (Cal. Ct. App. 1992); *Campbell v. People*, 814 P.2d 1, 8 (Colo. 1991) (in Colorado, *Frye* applied only to “novel scientific devices or processes involving the evaluation of physical evidence . . .”).

67. Roger S. Hanson, *James Alphonzo Frye Is Sixty-Five Years Old; Should He Retire?*, 16 W. ST. U. L. REV. 357, 411 (1989).

68. 509 U.S. 579 (1993).

69. 526 U.S. 137 (1999).

70. John W. Strong, *Language and Logic in Expert Testimony: Limiting Expert Testimony by Restrictions of Function, Reliability, and Form*, 71 OR. L. REV. 349, 361 (1992).

71. Hanson, *supra* note 67, at 411.

72. Strong, *supra* note 70, at 361.

73. *Id.*

74. *Id.* at 361-62.

75. *Id.* at 366.

76. *Id.* at 362.

77. *In re Lockheed Litig. Cases*, 23 Cal. Rptr. 3d 762, 781 (Cal. Ct. App. 2005); see Edward J. Imwinkelried & David L. Faigman, *Evidence Code Section 802: The Neglected Key to Rationalizing the California Law of Expert Testimony*, 42 LOY. L.A. L. REV. 427 (2008).

the exemptions on the ground that testimony based on hard science has a much greater impact on the jury than testimony based on soft science or nonscientific expertise. However, that claim is highly speculative. In a 1981 article and trial advocacy text intended primarily for practicing attorneys, the Author conjectured that lay jurors might be more skeptical of noninstrumental expert testimony.⁷⁸ The Author speculated that in the case of soft science, lay factfinders might think that rather than depending upon “sophisticated instruments capable of precise” measurement,⁷⁹ the value of the expert’s opinion turns on “the subjective, personal judgment of the witness.”⁸⁰ Although those statements were sheer conjecture, that conjecture was repeated in a 1987 article that has become the most widely cited secondary authority on the admissibility of nontraditional psychological evidence such as syndrome testimony.⁸¹ The 1987 article contended that such evidence should be exempt from the *Frye* test.⁸² The article asserted that unlike testimony about instrumental techniques, evidence based on “software” theories is “not likely to elicit unquestioning juror acceptance.”⁸³ As support for that proposition, the article cited only the previous 1981 article and cases such as *People v. McDonald*⁸⁴ indulging in similar speculation.⁸⁵ The reality, though, is neither the 1981 article nor the 1987 article pointed to any empirical studies bearing out the speculation.⁸⁶

Common sense suggests that testimony based on nonscientific expertise poses at least as great a danger of unreliability as testimony based on science. One of the great strengths of the scientific method is that it permits other scientists to later attempt to duplicate the earlier

78. Edward J. Imwinkelried, *Evidence Law and Tactics for the Proponents of Scientific Evidence*, in SCIENTIFIC AND EXPERT EVIDENCE 33, 64 (Edward J. Imwinkelried ed., 2d ed. 1981); 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, 283 (1981).

79. Imwinkelried, *A New Era*, *supra* note 78, at 283.

80. Imwinkelried, *Evidence Law and Tactics*, *supra* note 78, at 63-64.

81. David McCord, *Syndromes, Profiles and Other Mental Exotica: A New Approach to the Admissibility of Nontraditional Psychological Evidence in Criminal Cases*, 66 OR. L. REV. 19, 85-86 (1987).

82. *Id.* at 86-87.

83. *Id.* at 85-86.

84. 690 P.2d 709 (Cal. 1984).

85. McCord, *supra* note 81, at 86 n.311. In *People v. McDonald*, the court asserted that lay jurors have “a healthy skepticism” about psychological testimony. 690 P.2d at 724 (citing no empirical support for its assertion).

86. See Melvin B. Lewis, *The Element of Subjectivity in Interpreting Instrumental Test Results*, in SCIENTIFIC AND EXPERT EVIDENCE, *supra* note 78, at 409, 424-28.

test to see whether they can replicate the test result.⁸⁷ That facet of scientific methodology enabled subsequent researchers to debunk the infamous “cold fusion” claims by recreating the experiment and reaching a very different result. For the most part, that doublecheck is unavailable in the case of nonscientific expertise.⁸⁸ The upshot is that the concerns about the unreliability of soft science and nonscientific expertise are every bit as significant as the doubts relating to hard science. As Professor Giannelli has written, “[t]here is little justification . . . for exempting these techniques from close scrutiny,” because “[t]heir reliability is often questionable.”⁸⁹

These concerns are substantial because a large percentage of the expert testimony presented at trial falls into the categories that are exempt from *Frye*. During the Chicago Jury Project conducted in the 1960s, the researchers attempted to determine the types of expert witnesses called at trial. As previously stated, in *McDonald* the California Supreme Court indicated that it classifies medicine as soft science.⁹⁰ In the Chicago study, 43% of the experts called as witnesses were physicians.⁹¹ Another 6% were police officers or FBI agents providing nonscientific expert testimony on subjects such as the modus operandi of criminals.⁹² In a Rand Corporation study in the 1980s, roughly half of the expert witnesses were physicians.⁹³ Nonscientific expert witnesses accounted for another 9% of the court appearances.⁹⁴

At this point, it is difficult to predict how *Frye* jurisdictions will classify the new techniques being developed by the brain sciences. Because some techniques such as fMRI are heavily dependent on instrumentation, the courts should subject some of the techniques to the general acceptance test. However, even that is not a foregone conclusion given the court’s statement in *McDonald* that it had never applied *Frye* to medical testimony.⁹⁵ *Frye* jurisdictions have struggled over such

87. See JOHN ZIMAN, RELIABLE KNOWLEDGE: AN EXPLORATION OF THE GROUNDS FOR BELIEF IN SCIENCE 60, 63-64, 68, 75 (1978); see also Rockne P. Harmon & Edward J. Imwinkelried, *The Admissibility of Prosecution Evidence that the Defense Had the Opportunity to Retest the Physical Evidence that Was Analyzed by a Government Expert*, 37 N.E. J. CRIM. & CIV. CONFINEMENT (forthcoming 2011).

88. Edward J. Imwinkelried, *The Next Step After Daubert: Developing a Similarly Epistemological Approach to Ensuring the Reliability of Nonscientific Expert Testimony*, 15 CARDOZO L. REV. 2271, 2280 (1994).

89. 1 GIANNELLI & IMWINKELRIED, *supra* note 21, § 1.06[c], at 25.

90. See 690 P.2d at 723-24.

91. HARRY KALVEN, JR. & HANS ZEISEL, *THE AMERICAN JURY* 140 (1966).

92. *Id.*

93. Samuel R. Gross, *Expert Evidence*, 1991 WIS. L. REV. 1113, 1119 (1991).

94. *Id.*

95. 690 P.2d at 724.

questions as whether rape trauma syndrome falls within an exemption from the general acceptance test.⁹⁶ The jurisdictions have sometimes experienced considerable difficulty drawing the lines between hard science, soft science, and nonscientific expertise. Thus, there is a possibility that a number of *Frye* states will admit testimony based on some of the new brain science methodologies without requiring a showing of general acceptance. Further, as we have seen, even if the court elects to insist on that showing, general acceptance is only a rough, crude proxy for the real question: whether the theory or technique in question will enable the expert to accurately draw the inference to which he or she proposes testifying. Fortunately, the new analytic approach emerging post-*Daubert* gives the courts better tools for getting at that question.

II. THE NEW EPISTEMOLOGICAL APPROACH TO DETERMINING THE ADMISSIBILITY OF EXPERT TESTIMONY

In 1993 the Supreme Court rendered its decision in *Daubert v. Merrell Dow Pharmaceuticals, Inc.*⁹⁷ The *Daubert* line of authority differs from the *Frye v. United States*⁹⁸ regime in two fundamental respects.

A. *Negatively, the Cases in the Daubert Line of Authority Reject the Exemptions Recognized Under Frye*

As the introduction noted, in his opinion in *Daubert* Justice Blackmun addressed the meaning of “scientific . . . knowledge” in Rule 702.⁹⁹ Justice Blackmun noted that there had been a controversy over the “proper scope” of *Frye*.¹⁰⁰ However, he adopted a classically Newtonian, broad description of the process of formulating a hypothesis and then engaging in controlled laboratory experimentation or systematic field observation to either validate or falsify the hypothesis.¹⁰¹ It was immediately clear to the lower courts that the Justice had prescribed an expansive definition, seemingly applying to both hard and soft science. Indeed, contrast to *People v. McDonald*,¹⁰² the United States Court of Appeals for the Ninth Circuit held that the *Daubert* test applied to expert psychological testimony about the supposed unreliability of

96. 1 GIANNELLI & IMWINKELRIED, *supra* note 21, § 9.04[a], at 530.

97. 509 U.S. 579 (1993).

98. 293 F. 1013 (D.C. Cir. 1923).

99. 509 U.S. at 589-90.

100. *Id.* at 586.

101. *Id.* at 590.

102. 690 P.2d 709 (Cal. 1984).

eyewitness identification¹⁰³—the very type of expert testimony *McDonald* exempted from the general acceptance test.¹⁰⁴ It quickly became the prevailing view that *Daubert* had terminated the exemption that soft science had formerly enjoyed under *Frye*.¹⁰⁵ In many cases it will be more difficult to adapt scientific methodology to test propositions in the domain of soft science,¹⁰⁶ but that is an inadequate excuse for utterly abandoning the tradition of empirical investigation in that domain.

The question persisting after *Daubert* was whether there was still an exemption for nonscientific expertise. The advocates of that exemption presented two arguments. First, they pointed out that in *Daubert*, Justice Blackmun had cautioned that “[o]ur discussion is limited to the scientific context because that is the nature of the expertise offered here.”¹⁰⁷ Second, Rule 702 is worded in the alternative, referring to “scientific, technical, or other specialized knowledge.”¹⁰⁸ The wording of the opinion and the statute made it plausible to argue that unlike the exemption for soft science, the exemption for nonscientific expertise had survived the enactment of the Federal Rules of Evidence.

However, in 1999 when the Supreme Court finally reached the merits of the question in *Kumho Tire Co. v. Carmichael*,¹⁰⁹ the Court sounded the deathknell for that exemption. Justice Breyer delivered the Court’s opinion, and in doing so he relied on both statutory construction and policy arguments.¹¹⁰ As a matter of statutory interpretation, Justice Breyer believed that the key was the statute’s use of the term “knowledge.”¹¹¹ It was true that the statute employed three different adjectives to modify that noun. However, regardless of whether the expertise was scientific, technical, or specialized in character, the witness’s testimony had to be based on “knowledge.”¹¹²

In *Daubert* Justice Blackmun separately commented on the meaning of “knowledge” and “scientific,” and he expressly stated that “the word

103. *United States v. Amador-Galvan*, 9 F.3d 1414, 1417-18 (9th Cir. 1993).

104. 690 P.2d at 723.

105. Jennifer Sparks, Comment, *Admissibility of Expert Psychological Evidence in the Federal Courts*, 27 ARIZ. ST. L.J. 1315, 1318 (1995); see also *Klein v. Vanek*, 86 F. Supp. 2d 812, 817 (N.D. Ill. 2000); William M. Grove & R. Christopher Barden, *The Admissibility of Testimony From Mental Health Experts Under Daubert/Kumho Analyses*, 5 PSYCH., PUB. POL’Y & L. 224, 224-25 (1999).

106. See generally David L. Faigman, *To Have and Have Not: Assessing the Value of Social Science to the Law as Science and Policy*, 38 EMORY L.J. 1005 (1989).

107. 509 U.S. at 590 n.8.

108. FED. R. EVID. 702.

109. 526 U.S. 137 (1999).

110. *Id.* at 141, 147-49.

111. *Id.* at 147-48.

112. *Id.*

'knowledge' connotes more than subjective belief or unsupported speculation."¹¹³ Justice Breyer ruled that Congress's inclusion of "knowledge" in the statute mandated that all admissible expert testimony "have a reliable basis."¹¹⁴ After advancing that statutory construction argument, Justice Breyer discussed the policy question of whether it would be feasible to formulate varying admissibility standards for the different types of expertise proffered at trial.¹¹⁵ In his words, "[I]t would prove difficult, if not impossible, for judges to administer evidentiary rules under which a gatekeeping obligation depended upon a distinction between 'scientific' knowledge and 'technical' or 'other specialized' knowledge. There is no clear line that divides one from the others."¹¹⁶ The Court therefore declared that the trial judge must assure that the proffered expert testimony is "reliable . . . whether the testimony reflects scientific, technical, or other specialized knowledge."¹¹⁷

The Court was realistic enough to appreciate that it is dangerous to lump all expert testimony together. For that reason, after announcing the general reliability requirement under Rule 702, Justice Breyer distinguished between that requirement and the specific factors Justice Blackmun had suggested that trial judges consider in assessing the admissibility of expert testimony.¹¹⁸ Justice Breyer acknowledged that many of those factors such as peer review were derived from the basic model for scientific knowledge.¹¹⁹ He stated that in a case involving nonscientific expertise, one or some of those factors might be inappropriate.¹²⁰ The Justice accorded "the trial judge . . . considerable leeway in deciding in a particular case how to go about determining whether particular expert testimony is reliable."¹²¹ Hence, the trial judge not only possesses discretion in applying the *Daubert* factors to determine the admissibility of purportedly scientific testimony;¹²² the judge also enjoys latitude in selecting the factors to be employed as "reasonable measures of reliability" in the case of other types of expertise.¹²³

113. 590 U.S. at 590.

114. *Kumho Tire*, 526 U.S. at 148 (quoting *Daubert*, 509 U.S. at 592).

115. *Id.*

116. *Id.*

117. *Id.* at 149.

118. *See id.* at 150-51.

119. *Id.* at 149-50.

120. *Id.* at 150-53.

121. *Id.* at 152.

122. *See Gen. Elec. Co. v. Joiner*, 522 U.S. 136, 146 (1997).

123. *Kumho Tire*, 526 U.S. at 153.

Since the rendition of the decision in *Daubert*, commentators have generated an enormous body of scholarship debating the question of whether the *Frye* or *Daubert* standard is more rigorous.¹²⁴ In *Daubert* Justice Blackmun described the former standard as “rigid” and “austere” while he characterized the Federal Rules as “liberal” and “permissive.”¹²⁵ Yet, by 2000, in *Weisgram v. Marley Co.*,¹²⁶ the same Court stated that *Daubert* decrees “exacting standards of reliability.”¹²⁷ However, it is a mistake to fixate on that issue; just as a court under *Frye* could apply its standard in a liberal manner, a court following *Daubert* might apply its test in a conservative fashion.¹²⁸ In the long term, though, the question of the scope or reach of *Daubert* may prove to be far more important than its rigor or strictness. In that regard, it is undeniable that *Daubert*’s across-the-board reliability requirement applies to many types of expertise formerly exempt from scrutiny under *Frye*.

B. Affirmatively, the Daubert-Joiner-Kumho Line of Authority Requires the Courts to Adopt an Epistemological Approach, and that Approach can be Synthesized into a Three-Step Analysis

In *Daubert* Justice Blackmun focused on the meaning of “knowledge” in Rule 702.¹²⁹ He posed an essentially epistemological question: How can an investigator use Newtonian scientific methodology to come to know whether an hypothesis about a phenomenon is true?¹³⁰ When a scientist makes an assertion about a phenomenon, he or she is making a knowledge claim; epistemology requires an adequate basis or warrant for the claim.¹³¹ Under the *Daubert* line of authority, the trial judge must demand that the expert’s proponent lay a sufficient foundation to

124. E.g., Lloyd Dixon & Brian Gill, *Changes in the Standards for Admitting Expert Evidence in Federal Civil Cases Since the Daubert Decision*, 8 PSYCHOL., PUB. POL’Y & L. 251 (2002).

125. 509 U.S. at 588-89.

126. 528 U.S. 440 (2000).

127. *Id.* at 455.

128. 1 DAVID L. FAIGMAN ET AL., MODERN SCIENTIFIC EVIDENCE: THE LAW AND SCIENCE OF EXPERT TESTIMONY § 1.15, at 45-46 (2009-2010 ed.).

129. 509 U.S. at 590.

130. Imwinkelried, *The Next Step*, *supra* note 88, at 2277.

131. ALBUREY CASTELL, AN INTRODUCTION TO MODERN PHILOSOPHY 169 (2d ed. 1963).

validate the claim.¹³² To assess the sufficiency of the foundation, in sequence the trial judge ought to address three questions.¹³³

Question #1: What is the specific theory or technique that the expert proposes to rely on as the basis for his or her opinion?

It is not enough for the expert to explain that he or she is resting the opinion on his or her education or experience. In *General Electric Co. v. Joiner*¹³⁴ and *Kumho*, the Court said in no uncertain terms that the expert's ipse dixit assertion is an inadequate foundation.¹³⁵ If the basis of the expert's opinion is ineffable and inarticulable, it cannot qualify as "knowledge" under Rule 702. Further, the trilogy of Supreme Court decisions demonstrates that the question is not about the global validity of the expert's discipline.¹³⁶ In each opinion, the Court's analysis was highly particularized.

In the first decision in the trilogy, the original *Daubert* case, Justice Blackmun stated that the proponent's foundation must satisfy the trial judge that the expert's theory or technique is sufficiently reliable to perform "the task at hand."¹³⁷ The issue was not the overall standing of the discipline of epidemiology. Rather, the question was the validity of the metanalysis the plaintiffs' experts had conducted to validate the hypothesis that a mother's ingestion of Bendectin in the first trimester can cause the mother's child to suffer limb defects. Thirty published studies had investigated the question of whether Bendectin is a human teratogen. None of those studies had found a statistically significant correlation between Bendectin ingestion and limb defects. However, the plaintiffs' experts had pooled the data from the studies, reanalyzed the data, and teased a statistically significant finding out of the metanalysis.¹³⁸ The litigants did not waste any time disputing whether epidemiology is a recognized scientific discipline. Their focus was much sharper, concentrated on the metanalysis submitted by the plaintiffs.

Joiner lends itself to the same interpretation as *Daubert*. In *Joiner* Chief Justice Rehnquist analyzed the question of whether the animal

132. *Daubert*, 509 U.S. at 597.

133. See generally Edward J. Imwinkelried, *The Meaning of "Appropriate Validation" in Daubert v. Merrell Dow Pharmaceuticals, Inc., Interpreted in Light of the Broader Rationalist Tradition, Not the Narrow Scientific Tradition*, 30 FLA. ST. U. L. REV. 735, 749-64 (2003).

134. 522 U.S. 136 (1997).

135. *Kumho Tire*, 526 U.S. at 157-58; *Joiner*, 522 U.S. at 146.

136. See D. Michael Risinger, *Defining the "Task at Hand": Non-Science Forensic Science After Kumho Tire Co. v. Carmichael*, 57 WASH. & LEE L. REV. 767, 769-71 (2000).

137. 509 U.S. at 597.

138. *Id.* at 582-84.

studies cited by the plaintiff were an adequate basis for the expert's opinion as to the cause of Joiner's small-cell lung cancer.¹³⁹ The Chief Justice initially catalogued the criticisms of the animal studies.¹⁴⁰ The Chief Justice then wrote:

[Plaintiff] failed to reply to this criticism. Rather than explaining how and why the experts could have extrapolated their opinions from these seemingly far-removed animal studies, [plaintiff] chose "to proceed as if the only issue [was] whether animal studies can ever be a proper foundation for an expert's opinion." Of course, whether animal studies can ever be a proper foundation for an expert's opinion was not the issue. The issue was whether *these* experts' opinions were sufficiently supported by the animal studies on which they purported to rely.¹⁴¹

The *Kumho* opinion is cast in the same mold. *Kumho* echoes *Daubert's* reference to "the task at hand."¹⁴² In reviewing the foundation laid by the plaintiffs for Carlson's expert opinion, Justice Breyer narrowly defined the question presented as follows:

[C]ontrary to [plaintiffs'] suggestion, the specific issue before the [trial] court was not the reasonableness in general of a tire expert's use of a visual and tactile inspection to determine whether overdeflection had caused the tire's tread to separate from its steel-belted carcass. Rather, it was the reasonableness of using such an approach, along with Carlson's particular method of analyzing the data thereby obtained, to draw a conclusion regarding the particular matter to which the expert testimony was directly relevant.¹⁴³

Carlson had not rested his opinion simply on the general theory that, absent evidence of abuse, a defect will normally be the cause of a tire's separation. Rather, he had developed a more specific theory to establish the existence or absence of abuse.¹⁴⁴ Still later, Justice Breyer underscored that "the question before the trial court was specific, not general."¹⁴⁵

This approach makes epistemological sense. At any given time in a discipline, the propositions circulating will vary widely in the extent of the supporting validation.¹⁴⁶ Some may be so well

139. *Joiner*, 522 U.S. at 144.

140. *Id.*

141. *Id.* (third alteration in original) (citation omitted).

142. 526 U.S. at 141.

143. *Id.* at 153-54 (emphasis omitted).

144. *Id.*

145. *Id.* at 156.

146. Imwinkelried, *Appropriate Validation*, *supra* note 133, at 742-43.

established that they are judicially noticeable,¹⁴⁷ others might have barely enough validating research to pass muster, still others will lack adequate validation, and some may be flatly at odds with a massive amount of research. It makes little sense to discuss the general validity of the discipline. *Daubert*, *Joiner*, and *Kumho* are correct in directing the trial judge to demand that the expert identify the specific theory or technique he or she contemplates using.

Question #2: To what particular use or purpose does the expert propose putting the specific technique?

To be admissible, any item of evidence must be logically relevant.¹⁴⁸ Suppose that at trial, the opponent objected to the relevance of the testimony by the proponent's expert. The typical trial judge would not be content with the proponent's bald assertion that the testimony about the theory was "relevant." The judge would likely respond, "Tell me what fact of consequence this testimony is relevant to, and explain how the testimony is relevant to that fact." In *Daubert* Justice Blackmun went to the brink of explicitly identifying the second step in the analysis. He wrote that the testimony about the validation research must "fit":

"Fit" is not always obvious, and scientific validity for one purpose is not necessarily scientific validity for other[] . . . purposes. The study of the phases of the moon, for example, may provide valid scientific "knowledge" about whether a certain night was dark, and if darkness is a fact in issue, the knowledge will assist the trier of fact. However (absent creditable grounds supporting such a link), evidence that the moon was full on a certain night will not assist the trier of fact in determining whether an individual was unusually likely to have behaved irrationally on that night.¹⁴⁹

Even before *Daubert*, some courts perceived the importance of this inquiry. In a prior decision, the Missouri Supreme Court had approved of the use of neutron activation analysis (NAA) to determine whether a crime scene hair sample and the accused's hair had similar elemental composition.¹⁵⁰ However, the court refused to accept NAA testimony comparing a crime scene blood

147. *Daubert*, 509 U.S. at 592 n.11.

148. FED. R. EVID. 401.

149. *Daubert*, 509 U.S. at 591 (citation omitted).

150. *State v. Stout*, 478 S.W.2d 368, 371-72 (Mo. 1972).

sample and a sample of the accused's blood.¹⁵¹ The research validating the use of NAA to identify hair could not be stretched to uphold the use of NAA for an entirely different purpose.¹⁵² Likewise, in an earlier case the Minnesota Supreme Court held that rape trauma syndrome (RTS) had been adequately validated as a diagnostic tool to determine whether a rape complainant was suffering from a particular mental disorder.¹⁵³ Nevertheless, the court refused to permit prosecutors to treat the complainant's RTS as substantive evidence that a rape had occurred.¹⁵⁴

Once again the courts reached the right epistemological conclusion. The assertion that RTS enables an expert to determine whether a complainant has a certain state of mind is an entirely different knowledge claim than the assertion that RTS permits the expert to determine whether the complainant has been raped. Empirical data sufficient to support one knowledge claim may be a woefully inadequate warrant for a different knowledge claim. Thus, just as the trial judge must press the expert to articulate the specific theory or technique they intend to use, the judge should insist that the expert identify the purpose or use of the theory. For instance, does the expert ultimately want to draw an inference as to someone's credibility, or does the expert intend to testify to a conclusion as to whether some event occurred in the external world?¹⁵⁵

Question #3: Has the expert presented enough methodologically sound empirical reasoning to validate that particular use of the specific theory?

The first question relates to which technique the expert is using. The second concerns why the proponent is offering the testimony about the technique. The third and final question is the critical one: How should the proponent validate that particular use of that specific theory? The answers to the first two questions specify the content of the hypothesis to be

151. *Id.* at 371.

152. *Id.* at 371-72.

153. *State v. McGee*, 324 N.W.2d 232, 233 (Minn. 1982).

154. *Id.*; *State v. Saldana*, 324 N.W.2d 227, 229 (Minn. 1982).

155. If the expert does not specify the use, the wording of his or her final opinion is usually the best clue. For instance, if the rape crisis center expert proposes testifying to a final opinion that the complainant honestly believed that she had been raped although she delayed reporting the rape, the theory of logical relevance is credibility. However, when the expert contemplates opining that there was a rape, the expert is putting the theory to substantive use.

validated, and now the judge must assess the adequacy of the validation. At first blush this question may seem intimidating to a judge who lacks a Bachelor of Science degree. However, it is worth remembering Sir Karl Popper's observation that the scientific method is essentially "common-sense knowledge writ large."¹⁵⁶

That common sense is evident in the *Daubert* line of authority. In the initial *Daubert* decision, Justice Blackmun stressed the soundness of the expert's methodology: "The focus, of course, must be solely on principles and methodology, not on the conclusions that they generate."¹⁵⁷ As the Advisory Committee Note accompanying the 2000 amendment to Rule 702 states, the judge's task is to inquire as to the methodological soundness of the expert's validation of the theory or technique, not the correctness of the expert's opinion.¹⁵⁸ *Joiner* refined and elaborated on the *Daubert* analysis. Under *Joiner* the judge should not limit his or her analysis to the soundness of the expert's methodology; rather, the judge must also inquire whether there is *enough* methodologically sound research to support the expert's final conclusion:

Trained experts commonly extrapolate from existing data. But nothing in either *Daubert* or the Federal Rules of Evidence requires a district court to admit opinion evidence that is connected to existing data only by the *ipse dixit* of the expert. A court may conclude that there is simply too great an analytical gap between the data and the opinion proffered.¹⁵⁹

Epistemology mandates this final analytic step. In epistemology the crucial question is not whether there is some support for a knowledge claim. Rather, the decisive issue is whether there is enough or adequate support for the claim. Neither an epistemologist nor a trial judge is obliged to accept a person's assertion that specified data validates the claim. Both the epistemologist and the judge are entitled to employ their own experience and sense of logic to independently assess the connection between the claim and the supposed basis or warrant.

As previously stated, under the *Frye* regime the courts adopted a largely laissez-faire attitude toward nonscientific expertise because they found it so difficult to adapt the general accep-

156. KARL POPPER, THE LOGIC OF SCIENTIFIC DISCOVERY 22 (1959) (emphasis omitted).

157. 509 U.S. at 595.

158. FED. R. EVID. 702 Advisory Committee's Note.

159. 522 U.S. at 146.

tance standard to the evaluation of such expertise. However, the three-step analysis under *Daubert-Kumho* is flexible enough to enable judges to evaluate the reliability of even nonscientific expert testimony. Suppose, for example, that in a contract dispute between two members of the same industry, the outcome turns on the interpretation of the expression, “50% protein,” in the written agreement.¹⁶⁰ The plaintiff calls an expert to opine that in that industry, there is a linguistic convention that any seller’s shipment exceeding 49.5% protein is deemed to satisfy a “50% protein” contract requirement. The opinion is a knowledge claim. The expert is drawing on and summarizing his or her experience.¹⁶¹ There would be a sufficient warrant for that claim if the proponent’s foundation established that the witness had participated in a large number of transactions involving the expression “50% protein” within the industry and that in those transactions, the buyers usually accepted any shipment exceeding 49.5% protein.

Or suppose that in a criminal case, the prosecutor calls a police officer, the handler of a trained narcotics detection dog, to testify that there were drugs in the accused’s vehicle because the dog alerted the police officer to the vehicle. Here too, the witness is making a knowledge claim. However, the claim differs radically from the claim in the previous hypothetical. In this hypothetical, the officer is claiming that he or she knows that the vehicle contained contraband drugs because the dog behaved in a certain way. To justify that claim, the proponent must demonstrate the dog’s record of success.¹⁶² In the officer’s experience, how often has the dog “alerted” in that manner? In what percentage of those cases was there a follow-up search, and what percentage of those searches yielded drugs?¹⁶³ In the macrocosm, we have faith in science for the pragmatic reason that we have witnessed an “immense body of results,” successful applications of scientific theories and techniques.¹⁶⁴ In the microcosm of this hypothetical, an epistemologist would accept

160. *E.g.*, *Hurst v. W.J. Lake & Co.*, 16 P.2d 627, 628 (Or. 1932) (internal quotations omitted).

161. Imwinkelried, *Appropriate Validation*, *supra* note 133, at 753.

162. *See United States v. Winters*, 600 F.3d 963, 967-68 (8th Cir. 2010).

163. *See Pappas v. Sony Elecs., Inc.*, 136 F. Supp. 2d 413, 425 & n.16 (W.D. Pa. 2000) (test for reliability of expert testimony grounded in part in success in employing the method).

164. ZIMAN, *supra* note 87, at 6-7, 10.

the officer's knowledge claim only if the officer demonstrates that prior experiences with the dog show that, based on the dog's alert, the officer can accurately determine whether a vehicle contains illegal drugs—simply stated, the results of the prior uses of the technique.

III. THE UTILITY OF THE NEW APPROACH FOR DETERMINING THE
ADMISSIBILITY OF TESTIMONY BASED ON NEW BRAIN SCIENCE
THEORIES AND TECHNIQUES

Part II synthesized the *Daubert v. Merrell Dow Pharmaceuticals, Inc.*¹⁶⁵ case law to outline a new three-step approach to determining the admissibility of expert testimony, whether that testimony rests on hard science, soft science, or nonscientific expertise. Of course, given the topic of this Symposium, the vital question is whether that approach will prove useful for assessing the reliability and admissibility of testimony based on the new insights from the brain sciences. To explore that question, we shall discuss two brain science techniques mentioned in the introduction, EEG and BOLD fMRI. As we shall see, this discussion illustrates how effectively the courts can apply the new approach to breakthroughs in brain science.

A. *Electroencephalography*

To apply the new admissibility approach to EEG evidence, the initial step is identifying the theory or technique being used. The obvious answer is the EEG instrument. The next step is determining the purpose for which the proponent is offering the testimony about the technique. As the introduction suggested, there are several uses of the EEG.

One use is to diagnose brain damage. Merging the answers to the first two questions, the hypothesis to be investigated is whether the EEG can be used to accurately diagnose the existence of certain types of brain injury. It would be a straightforward matter to design an experimental protocol to validate this hypothesis. A researcher might suspect that if a particular region of the brain has suffered a certain type of injury, an EEG will show brain waves of a certain timing and amplitude.¹⁶⁶ To establish the diagnostic specificity of those brain waves, the researcher could test persons who display all

165. 509 U.S. 579 (1993).

166. GORDON M. SHEPHERD, *NEUROBIOLOGY* 553 (3d ed. 1994).

the classic symptoms of the brain injury and compare persons who manifest none of the symptoms. Suppose that the comparison yielded the finding that EEGs of the former group uniformly produced waves of that timing and amplitude while none of the EEGs of the latter group recorded such waves. That finding would lend strong support to the hypothesis. However, consider another potential use of EEG. As the introduction pointed out, Dr. Farwell's research concentrates on the use of EEG as a lie detector.¹⁶⁷ Both the Federal Bureau of Investigation (FBI) and the Central Intelligence Agency (CIA) have provided funding to support research into this use of EEG.¹⁶⁸

Once again, it is necessary to apply the new, *Daubert*-style analysis. Merging the answers to the first two questions, there is a very different hypothesis to study. The new hypothesis is whether EEG can be employed to accurately determine whether a person is being untruthful when he or she answers a particular question. Dr. Farwell has tendered opinions based on this use of EEG in several cases. In an Iowa case,¹⁶⁹ the accused applied for post-conviction relief. The accused argued that there was newly discovered exculpatory evidence, including an EEG examination, which Dr. Farwell contended demonstrated that the accused lacked knowledge of essential facts of the crime.¹⁷⁰ The Iowa Supreme Court granted relief, but did so on the ground of a due process violation rather than Dr. Farwell's opinion.¹⁷¹ Although the court mentioned Dr. Farwell's analysis in its opinion, it is unclear the extent, if any, to which the EEG analysis influenced the court's decision. In a 2005 Oklahoma case,¹⁷² an EEG examination was again submitted in support of a petition for post-conviction relief.¹⁷³ The judge refused to consider the EEG results and stated that the testimony could probably not survive a *Daubert* analysis.¹⁷⁴ Similarly, in 2009 a New Jersey trial court rejected the use of EEG as a lie detector.¹⁷⁵

167. See *supra* text accompanying notes 3, 6, 7.

168. U.S. GEN. ACCOUNTING OFFICE, GAO-02-22, INVESTIGATIVE TECHNIQUES: FEDERAL AGENCY VIEWS ON THE POTENTIAL APPLICATION OF "BRAIN FINGERPRINTING" at 1 (2001).

169. *Harrington v. State*, 659 N.W.2d 509 (Iowa 2003).

170. *Id.* at 512, 515-16 & n.6.

171. *Id.* at 525.

172. *Slaughter v. State*, 108 P.3d 1052 (Okla. Crim. App. 2005).

173. See *id.* at 1054.

174. *Id.*

175. *State v. Bates*, No. 34-2007, 2009 WL 981839, at *2 (N.J. Super. Mar. 23, 2009).

It is understandable why the courts' reaction to this use of EEG has been so unfavorable. While EEG is widely used to diagnose brain injury, employing it to detect deception necessitates different validation. Presumably, brain injuries automatically and involuntarily produce the waves that are allegedly diagnostic. In contrast, this use of EEG relates to conscious decisions to deceive. Positing EEG's ability to detect involuntary, diagnostic waves hardly dictates the conclusion that EEG can be used to accurately detect deliberate deception.

There are grave doubts about the adequacy of the validation for this adaptation of EEG. One variation of the available research is a "guilty knowledge" test.¹⁷⁶ The researchers theorize that if an interrogator reveals a fact about the crime under investigation and the interogee knows that fact, the interogee's recognition of the fact will produce a certain type of brain wave.¹⁷⁷ However, some of the research findings are discouraging. In one 2008 study in which the subjects were instructed to use countermeasures to confuse the test, the subjects employing the countermeasures were correctly classified only 7%-27% of the time¹⁷⁸—an accuracy rate far below random chance. The existence of effective countermeasures is one of the leading reasons why in its 2003 report, the Office of Technology Assessment (OTA) expressed skepticism about the adequacy of the empirical validation of polygraph's accuracy as a technique for detecting conscious deception.¹⁷⁹ If countermeasures can reduce the accuracy rate below 50%, any epistemologist or judge would be hard-pressed to conclude that there is a sufficient proof or warrant for this knowledge claim.

B. Blood-Oxygenation-Level-Dependent functional Magnetic Resonance Imaging (BOLD fMRI)

Here too the new *Daubert*-style analytic framework is helpful in separating the wheat from the chaff. Structural MRI produces

176. Lawrence A. Farwell & Emanuel Donchin, *The Truth Will Out: Interrogative Polygraphy ("Lie Detection") with Event-Related Brain Potentials*, 28 PSYCHOPHYSIOLOGY 531, 531 (1991).

177. See Ewout H. Meijer et al., *The P300 is Sensitive to Concealed Face Recognition*, 66 INT'L J. PSYCHOPHYSIOLOGY 231, 231 (2007).

178. Ralf Mertens & John J. B. Allen, *The Role of Psychophysiology in Forensic Assessments: Deception Detection, ERPs, and Virtual Reality Mock Crime Scenarios*, 45 PSYCHOPHYSIOLOGY 286, 293 (2008).

179. 1 GIANNELLI & IMWINKELRIED, *supra* note 21, § 8.03[e], at 436.

extremely detailed, static images of soft tissue. For its part, fMRI can visualize changes such as brain activity that occur over time. BOLD fMRI is often used to monitor such brain activity. The brain cannot store energy locally. Rather, its activity depends on a regular blood flow to bring fresh oxygen to its cells.¹⁸⁰ The brain's dependence on a constant oxygen supply enables BOLD fMRI to indirectly detect neural activity. Within a few seconds after the neurons in an area of the brain fire, that area experiences an influx of highly oxygenated blood.¹⁸¹ Deoxygenated hemoglobin reduces the MRI signal. When the local ratio of oxygenated to deoxygenated hemoglobin increases, more MRI signal will be observed.¹⁸² In other words, there will be a noticeable change in the MRI signal in the area of the brain that activates. Although fMRI does not directly measure neuronal activity, it detects changes in the metabolic demands of active neurons. Like EEG, fMRI has been put to several uses, posing varying challenges under *Daubert*.

As the introduction indicated, some researchers have used BOLD fMRI to identify surgical patients' vocal centers.¹⁸³ Obviously, the surgeon does not want to inadvertently damage a patient's language functions while the surgeon is performing an unrelated operation. If a brain surgeon can identify a patient's vocal center in advance, he or she can give the center a wide berth during the surgical procedure.

Suppose that after brain surgery, a patient experiences a loss of language function. The patient sues the surgeon for malpractice and alleges that the surgeon was guilty of professional negligence precisely because the surgeon did not put BOLD fMRI to this use before beginning the surgery. At trial, the plaintiff proffers testimony about this use of fMRI. Should the judge admit the testimony? If we apply the analytic framework outlined in Part II, the answer to the first question is BOLD fMRI. The answer to the second question is the use of the technique to identify the part of the patient's brain controlling vocal functions. Those two answers specify the scientific hypothesis, that is, that the instrument can be used to accurate-

180. Henry T. Greely & Judy Illes, *Neuroscience-Based Lie Detection: The Urgent Need for Regulation*, 33 AM. J.L. & MED. 377, 380 (2007).

181. Henry T. Greely, *Law and the Revolution in Neuroscience: An Early Look at the Field*, 42 AKRON L. REV. 687, 694 (2009).

182. *Id.*

183. See *supra* text accompanying note 5.

ly isolate the vocal center. A researcher could marshal several types of experiments to convince a trial judge that there is adequate validation for that hypothesis. To begin with, the researcher could generate scans of the same person speaking and remaining silent; the differences between the images ought to help the researcher locate the person's vocal center. The researcher could supplement that research with studies of the brain activity of mute individuals. In addition, if the researcher could identify subjects who were gradually losing speech function, the researchers could conduct a longitudinal study to locate the brain areas where the MRI signal was declining. Using common sense and a bit of creativity, a researcher could fairly easily design a set of experiments that would satisfy any epistemologist or trial judge that there is adequate support for the knowledge claim.

The parallel to EEG brain science continues. The introduction noted that as in the case of EEG, some fMRI researchers are endeavoring to use the technique to detect conscious deception.¹⁸⁴ The fMRI researchers are a bit behind the EEG researchers, because there have been less than a handful of attempts to offer this testimony in court yet.¹⁸⁵

There have been approximately twenty studies investigating this adaptation of fMRI.¹⁸⁶ However, after surveying the data in these studies, a trial judge who takes to heart the Court's caveat about unjustified extrapolation¹⁸⁷ would think long and hard before holding that there is sufficient basis for this knowledge claim. There are a number of reasons for caution:

184. Sean A. Spence et al., *If Brain Scans Really Detected Deception, Who Would Volunteer to be Scanned?*, 55 J. FORENSIC SCI. 1352, 1352 (2010); see also *supra* text accompanying note 3.

185. In May 2010, in the federal fraud prosecution of Lorne Semrau, the defense endeavored to introduce fMRI testimony to negate the accused's intent to cheat. Greg Miller, *fMRI Lie Detection Fails a Legal Test*, 328 SCIENCE, June 11, 2010, at 1336, 1336. The defense attempted to introduce testimony about scans performed by Cephos. Federal magistrate judge Tu Pham barred the testimony. On one hand, the judge found that the underlying hypothesis is testable and acknowledged that there are several, peer-reviewed articles discussing the use of fMRI for lie detection. On the other hand, he emphasized that "[t]here are no known error rates for fMRI-based lie detection outside the laboratory setting, i.e. in the 'real world.'" *Id.* at 1337.

186. Spence, *supra* note 184, at 1352.

187. *General Elec. Co. v. Joiner*, 522 U.S. 136, 146 (1997).

- Almost all the studies involve male Caucasians who neither suffer from mental illness nor use illicit drugs. In both respects, the database does not represent the universe of persons who tend to populate American prisons.¹⁸⁸
- While some studies report an impressive overall accuracy of 90%,¹⁸⁹ others found a specificity of only 42%.¹⁹⁰ To some extent, interlaboratory variation is expectable because laboratories at the cutting edge of pioneering research often use different study designs. What is more disturbing, however, is that on occasion individual laboratories have encountered difficulty replicating their own prior results.¹⁹¹
- In all the published studies, the subjects are instructed to lie. It is possible that the signal detected is prompted by the decision to comply with the instruction rather than a choice to deceive. The researcher is extrapolating from data involving compelled deceit to situations in which the subject voluntarily chooses to lie.
- The design of the published studies is artificial, because the test subject has little incentive to avoid detection. It is true that in some studies, the subject receives a monetary reward if he or she succeeds in concealing the deception from the researcher. However, those incentives pale in comparison to the incentive of a criminal to lie to prevent conviction or of a spy to lie to avoid being exposed.
- There has been even less investigation of the vulnerability of fMRI to countermeasures than there has been in the case of EEG.

In this light, an epistemologist could quite consistently conclude that there is sufficient warrant for the knowledge claim with respect to the identification of patients' voice center

188. See John Seabrook, *Suffering Souls: The Search for the Roots of Psychopathy*, NEW YORKER, Nov. 10, 2008, http://www.newyorker.com/reporting/2008/11/10081110/fa_fact_seabrook?currentPage=all.

189. F. Andrew Kozel et al., *Detecting Deception Using Functional Magnetic Resonance Imaging*, 58 BIOLOGICAL PSYCHIATRY 605, 605 (2005).

190. F. Andrew Kozel et al., *Functional MRI Detection of Deception After Committing a Mock Sabotage Crime*, 54 J. FORENSIC SCI. 220, 226 (2008).

191. Daniel D. Langleben et al., *Telling Truth From Lie in Individual Subjects with Fast Event-Related fMRI*, 26 HUM. BRAIN MAPPING 262, 270 (2005); Sean A. Spence, *Playing Devil's Advocate: The Case Against fMRI Lie Detection*, 13 LEGAL & CRIMINOLOGICAL PSYCH. 11, 11 (2008).

but patently inadequate warrant for the claim regarding deception detection.¹⁹²

IV. CONCLUSION

Hopefully, the reader will come away from this Article with two impressions. The first is that at its base, the new *Daubert-Kumho* framework for analyzing the admissibility of expert testimony is an epistemological approach. An expert appearing at trial is making a knowledge claim. Like an epistemologist, the trial judge should demand clear answers to the three questions identified in Part II. The second impression is that this new epistemological approach will be useful in determining which products of the new brain sciences should be used during the adjudicative¹⁹³ process in the courtroom.

Of course, we should not understate the difficulty of this undertaking. Because of the exemptions from the *Frye* test, modern courts following the *Daubert-Kumho* line of authority are writing on a tabula raza; they are endeavoring to critically evaluate the validity of theories and techniques that escaped scrutiny under *Frye*. A forte of the common law is its ability to accumulate judicial experience with a legal doctrine and to capitalize on that experience to reform the doctrine.¹⁹⁴ However, the exemptions denied the courts the opportunity to gain experience dealing with soft science and nonscientific expertise. Given the court's observation in *McDonald* about "medical" testimony, it is conceivable that even today some courts following *Frye* would admit testimony about new brain science techniques without meaningfully scrutinizing the techniques. However, as Part III of this Article demonstrated, the epistemological mindset implicit in the *Daubert* line will serve the courts well when they are asked to assess the knowledge claims made by brain scientists.

192. See Frederick Schauer, *Can Bad Science Be Good Evidence? Neuroscience, Lie Detection, and Beyond*, 95 CORNELL L. REV. 1191, 1191-1210 (2009).

193. Again, the formal rules of evidence such as Rule 702 and *Daubert* are not applied as strictly when the litigator uses brain science data for a normative or legislative purpose rather than an adjudicative one. See *supra* text accompanying notes 10-17. Likewise, many jurisdictions apply more relaxed evidentiary rules at the sentencing phase. Neuroscience evidence is sometimes proffered during sentencing. See Scott N. MacMillan & Michael S. Vaughn, *Weighing the Evidence: Neuroimaging Evidence of Brain Trauma or Disorder in Courts*, 46 CRIM. L. BULL. 495, 500-01 (2010).

194. PAUL J. MISHKIN & CLARENCE MORRIS, ON LAW IN COURTS: AN INTRODUCTION TO JUDICIAL DEVELOPMENT OF CASE AND STATUTE LAW 230 (1965).

The courts will not only have to face the short-term challenge of passing on the admissibility of testimony based on the theories and techniques that the brain sciences produce in the near future. In addition, the courts must be prepared to revisit these issues. In epistemology, the ultimate question is always the adequacy of the warrant for the knowledge claim.¹⁹⁵ Worldwide, brain researchers are generating new data at a breathtaking pace. That new data can either strengthen a warrant previously deemed inadequate or undermine a warrant formerly considered sufficient. When a knowledge claim rests on empirical data and the state of the data changes, the court must be ready to rethink the admissibility of testimony based on the claim. It is serendipity that the advent of the *Daubert* line of cases roughly coincided with the emergence of the new brain sciences. However, it would be a mistake to think that the initial *Daubert* rulings made on new brain science techniques will settle the admissibility issues once and for all. Especially in areas such as contemporary brain science, the empirical research is ongoing and dynamic. Given the evolving nature of the research, an epistemologist cannot make a truly definitive pronouncement on the validity of the theory,¹⁹⁶ nor can a trial judge who understands the fundamentally epistemological nature of the *Daubert* standard.

195. CASTELL, *supra* note 131, at 169.

196. Brief for the American Association for the Advancement of Science and the National Academy of Sciences as Amici Curiae Supporting Respondent at 6, *Daubert v. Merrell Dow Pharmaceuticals, Inc.*, 509 U.S. 579 (1993) (No. 92-102), 1993 WL13006381.