



NEW MEXICO LAW REVIEW

Volume 46
Issue 2 *Summer*

Summer 2016

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Recommended Citation

Jason P. Kerkmans & Lynn M. Gaudet, *Daubert on the Brain: How New Mexico's Daubert Standard Should Inform its Handling of Neuroimaging Evidence*, 46 N.M. L. Rev. 383 (2016).

Available at: <https://digitalrepository.unm.edu/nmlr/vol46/iss2/5>

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DAUBERT ON THE BRAIN: HOW NEW MEXICO'S DAUBERT STANDARD SHOULD INFORM ITS HANDLING OF NEUROIMAGING EVIDENCE

Jason P. Kerkmans and Lyn M. Gaudet*

INTRODUCTION

The scientific and expert evidence admissibility standard as set forth in *Daubert v. Merrell Dow Pharmaceuticals, Inc.*¹ and its progeny have been the subject matter of legal scholarship for more than two decades. *Daubert* remains the reigning guidance on how to approach the admissibility of scientific evidence and has been adopted by the majority of jurisdictions across the country. Since being decided *Daubert* has also been the subject of much fear and relief, support and challenge from attorneys seeking both greater and lesser limits on the inclusion of scientific evidence in the courtroom. Regardless of whether one believes judges should enforce their power in deciding where the line between junk science and real science is drawn, or if the fact finder should see all evidence and determine its weight accordingly, *Daubert* is as relevant today as it was in 1993 when the case was decided. This paper seeks to add to the body of literature on how best to analyze scientific evidence by highlighting the importance of a recent contribution to legal scholarship and its application to the growing amount of proffered neuroimaging evidence. Specifically, this paper discusses the G2i framework as articulated by law Professors Faigman, Monahan, and Slobogin, when evaluating proffered expert evidence and corresponding testimony in states that have adopted the *Daubert* approach. Taking a bifurcated view of all expert evidence, the G2i framework provides courts with the structure for assessing the reliability of both the scientific theory's general proposition and the individual application of that general proposition to the facts at hand.

Part I of this article reviews the expert evidence admissibility standard set forth in *Daubert v. Merrell Dow Pharm., Inc.* and New Mexico's adoption of the *Daubert* standard in *State v. Alberico*.² Part II of the article provides a summary of the framework expressed in the 2014 publication *Group to Individual (G2i) Inference in Scientific Expert Testimony*.³ Part III explores case law where DNA testing was considered as evidence and why the courts have concluded that DNA evidence complies with *Daubert/Alberico* standards. Part IV provides a summary of

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1. 509 U.S. 579 (1993).

2. 1993-NMSC-047, 861 P.2d 192.

3. David L. Faigman, John Monahan & Christopher Slobogin, *Group to Individual (G2i) Inference in Scientific Expert Testimony*, 81 U. CHI. L. REV. 417 (2014).

the use of neuroimaging evidence in court and provides an overview of the different neuroimaging techniques being used. Neuroimaging evidence is being increasingly offered in both criminal and civil cases and as a result we believe that a basic familiarity with the different types of techniques is important for all jurists. Part V highlights the distinction between novel science and clinically-established science in showing that *Daubert* finds its highest purpose when evaluating novel techniques and theories. Part VI concludes that certain types of neuroscience data can be and has been deemed reliable at both the general and individual level through the application of *Daubert* under a G2i framework.

I. THE DEVELOPMENT OF EXPERT EVIDENCE ADMISSIBILITY REQUIREMENTS

When it comes to expert evidence, what is unquestionably clear is that expert opinions should be deemed reasonably reliable before being presented as evidence. Requiring that evidence meet a reasonable benchmark of reliability before being admitted, however, does not mean novel and emerging scientific methods and processes should not be admitted. The underlying scientific question does not have to be, nor should it be, settled in order for a fact finder to weigh the value of the resulting conclusions. The distinction between what is novel and reliable versus novel and junk science, however, is a rope the law has been tugging back and forth for centuries.

A. The Federal Cases

As early as the 14th century, as jury trials became ever more frequent, the need for witness-provided information outside of the tribunal's inherent expertise became an important component of the judicial system. Juries were often impaneled entirely of people with expertise in the underlying subject of the litigation, i.e. "persons specially qualified to pass judgment in a particular case."⁴ The alternative was for the court to "summon skilled persons to inform it about those matters beyond its knowledge."⁵ Under this method the court could decide whether expert testimony was fit for the jury to consider. Even when the court was acting as the ultimate gatekeeper, choosing which experts were called to discuss a matter, it could disregard the testimony it solicited if the court did not think that information was reliable enough for the jury to hear.⁶

It was in the 16th century when witness testimony could be presented directly to the jury.⁷ This led to an inquisitorial system, whereby only jurors who had direct knowledge of the case were pulled from the community. By the 17th century, courts first began to permit experts on both sides of the case to present information.⁸

4. Lloyd L. Rosenthal, *The Development of the Use of Expert Testimony*, 2 L. & CONTEMP. PROBS. 403, 407 (1935).

5. *Id.*

6. *See id.*

7. *Id.* at 408–09.

8. *Id.* at 409–10 ("By 1678 . . . [i]n . . . *Rex v. Pembroke*, a murder trial, both the prosecution and defense called physicians to testify to the causes of symptoms observed in an autopsy and to the proposition whether a person can die of wounds without fever. Similarly, in the next year in another

No longer were these experts delivering information only to the court, which alone chose whether, and in which form, that information would be given to the jury.⁹ And no longer were experts commenting at the request of the court, but were now being brought in at the request of the two opposing parties.¹⁰ The court's formerly solid role as the gate builder and keeper began to dissolve.

By the 18th century, an individual's personal knowledge of the dispute before the court disqualified that individual as a juror.¹¹ And at the time, expert testimony was largely subject to the same admissibility rules as any other witness testimony.¹² Yet, as more expert evidence was introduced, liberal admissibility standards raised concerns as to the reliability of the evidence. Opponents of this practice argued that there needed to be a verification process to reconcile the reliability of dueling expert opinions.¹³

In 1923, the Federal Circuit Court of Appeals was the first to address the issue of reliability in the context of expert testimony in *Frye v. United States*.¹⁴ The case arose from James Alphonso Frye's appeal of a second-degree murder conviction. Frye argued that his expert should have been permitted to testify on the results from an early lie detector test that showed Frye was innocent.¹⁵ Frye further argued that "when the question involved does not lie within the range of common experience or common knowledge, but requires special experience or special knowledge, then the opinions of witnesses skilled in that particular science, art, or trade to which the question relates are admissible in evidence."¹⁶ The court disagreed, refusing to hold that special or expert knowledge alone was enough to grant admittance. Rather, *Frye* held that the expert witness must be an expert in the given field and also share an opinion that is generally accepted by the expert's scientific peers.¹⁷

Critics of the *Frye* decision argue that courts are either unwilling or unable to conduct wide surveys of the relevant scientific communities to properly gauge if

murder trial, *Rex v. Green et al*, two surgeons, who had viewed the body of the victim, were summoned by the prosecution in order to give their opinion as to the cause and manner of death and as to the length of time the victim had been dead when viewed. In 1682, again in a murder prosecution, *Rex v. Coningsmark*, a surgeon was summoned by the crown to offer his opinion as to the nature of bullet wounds, the cause of death, and also the type of wound which certain bullets could produce. And in the celebrated trial of Spencer Cowper for the murder of Sarah Stout in 1699 there was much medical testimony produced by the prosecution and defense concerning the cause of death.") (footnotes omitted).

9. *See id.*

10. *See id.*

11. Mason Ladd, *Expert Testimony*, 5 VAND. L. REV. 414, 415 (1952).

12. *See* Jack B. Weinstein, *Improving Expert Testimony*, 20 U. RICH. L. REV. 473, 475 (1986) ("it was 'a mistake to think of some witnesses as experts and others as non-experts.'" (quoting 1 JOHN HENRY WIGMORE, A TREATISE ON THE SYSTEM OF EVIDENCE IN TRIALS AT COMMON LAW § 555, at 668 (1904))).

13. *See, e.g.*, Weinstein, *supra* note 12.

14. 293 F. 1013 (D.C. Cir. 1923).

15. *Id.* at 1014.

16. *Id.*

17. *Id.* ("Just when a scientific principle or discovery crosses the line between the experimental and demonstrable stages is difficult to define. Somewhere in this twilight zone the evidential force of the principle must be recognized, and while courts will go a long way in admitting expert testimony deduced from a well-recognized scientific principle or discovery, the thing from which the deduction is made must be sufficiently established to have gained general acceptance in the particular field in which it belongs.").

an idea or opinion is generally accepted.¹⁸ Furthermore, numerous cases establish that courts generally rely on precedential acceptance of a given scientific concept rather than the general acceptance of the principle by the relevant scientific field.¹⁹

Despite its short comings, *Frye* was “praised as guaranteeing uniformity of decisions, eliminating the need for prolonged admissibility hearings, and providing an effective method to determine the admissibility of the evidence by specialists.”²⁰ It took seven decades for the wall of uniformity that *Frye* offered to genuinely come under fire. In the 1990s, a set of proposed amendments to the Federal Rules of Evidence aimed to place even further limitations on expert testimony.²¹

Before those proposed amendments to the Federal Rules of Evidence could be adopted,²² the U.S. Supreme Court addressed the admissibility of expert testimony in *Daubert v. Merrell Dow Pharmaceuticals, Inc.*²³ In *Daubert*, a unanimous court held that trial judges must determine the relevancy or fit of the evidence,²⁴ the qualifications of the expert,²⁵ and determine if the testimony itself is “supported by appropriate validation.”²⁶ In the Court’s own words, “in order to qualify as ‘scientific knowledge,’ an inference or assertion must be derived by the scientific method.”²⁷ And scientific knowledge, so defined, has “evidentiary reliability—that is, trustworthiness.”²⁸

The Court did not directly overrule *Frye* by requiring judges to assess the trustworthiness of witnesses. Rather, the Court was responding to the Federal Rules of Evidence, which were nearing the end of their second decade in practice. Specifically, the Court held that the Federal Rules of Evidence changed whether “general acceptance” was required in admission of expert testimony.²⁹ Thus, *Frye* was no longer the standard in federal court, and instead, the Court held that the Federal Rules of Evidence favored a permissive inclusion of expert testimony.

The admission of expert evidence had oscillated back toward the court-led process favored in the 17th century, by once again letting the judge decide what testimony made it to the jury. Under *Frye* the judge was bound to accept the relevant scientific community’s recognition or rejection of the principle at issue (at least in

18. See David L. Faigman, *The Daubert Revolution and the Birth of Modernity: Managing Scientific Evidence in the Age of Science*, 46 U.C. DAVIS. L. REV. 893, 901 (2013). (“Trial courts tend to be convinced by testifying experts’ assurances that the bases for their opinions are generally accepted, though few experts are likely to have surveyed the field themselves or have access to such surveys done by others.”).

19. *Id.* at 901–902.

20. Janusz Puzniak, *Expert Evidence: The Road from Daubert to Joiner and Kumho Tire*, CT. REV., Fall 2000, at 33.

21. *Id.* at 34.

22. *Id.*

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

24. *Id.* at 591 (“‘Fit’ is not always obvious, and scientific validity for one purpose is not necessarily scientific validity for other, unrelated purposes.”).

25. *Id.* at 588 (“[A] witness qualified as an expert by knowledge, skill, experience, training, or education, may testify thereto in the form of an opinion or otherwise.”) (quoting FED. R. EVID. 702).

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

27. *Id.*

28. *Id.* at 590 n.9.

29. *Id.* at 588.

theory). Yet under *Daubert*, the judge was free to weigh the evidence on her own with guidance from the scientific community.

That guidance comes in the form of the four well-familiar factors created to help guide courts in their evaluation of proffered scientific knowledge. First, the court can look at whether the scientific principle has been tested or is capable of being tested.³⁰ Second, the error rate behind a scientific process and just what level that error rate reaches should be considered by the courts.³¹ Third, whether the scientific method or process used by the expert has been subject to peer review and publication.³² And fourth, harkening back to *Frye*, whether there is a general acceptance for the theory being presented.³³ *Daubert* does not limit a judge to the use of these four tools alone. While there has been some development of additional factors at the trial level, *Daubert's* four factors are the most favored analysis tools used by trial courts. Therefore, the importance of each factor should be evaluated in depth.

Under the first factor, the testability of the technique or results underlying the proposed scientific testimony can be robust in scope. At its most general level, the method or technique used to reach a decision should be evaluated for whether it can be tested. An inquiry at this broad scope level would be: “has the method used been tested or was it testable by the expert seeking to present the testimony?” At a narrower scope, the expert’s application of that general method should be reviewed for testability. For example, even in cases where an expert testifies based on their years of experience, *Daubert* instructs the court to look at whether data could have been collected and tested in an attempt to disprove a hypothesis based on that experience alone.³⁴

Under the second factor, a possible evaluation of the scientific technique’s error rate directs the court to consider if the technique is standardized, and if so, what does the scientific community know about the likelihood of reaching a false result. While *Daubert* does not set a bright line acceptable error rate, it is clear that statistical evaluation of the underlying figures should be considered.³⁵ A proper error-rate evaluation, therefore, requires judges to have a general statistical understanding.³⁶ Additionally, error rates deemed within the adequate standards of the relevant scientific specialty can be instructive and help guide a judge’s statistical inquiry.³⁷

Under the third factor, trial courts must look at whether the underlying method had been subject to peer review and publication. Yet, *Daubert* underscores

30. *Id.* at 593.

31. *Id.* at 594.

32. *Id.* at 593–94.

33. *Id.* at 594.

34. *Id.* at 592.

35. *Id.*; see also Munia Jabbar, *Overcoming Daubert’s Shortcomings in Criminal Trials: Making the Error Rate the Primary Factor in Daubert’s Validity Inquiry*, 85 N.Y.U. L. Rev. 2034, 2037 (2010) (arguing for the importance of error rates in determining the admissibility of forensic science evidence).

36. See Jed S. Rakoff, *Science and the Law: Uncomfortable Bedfellows*, 38 SETON HALL L. REV. 1379, 1383 (2008) (“But even a thirteen percent error rate is pretty high when you are dealing with something as important as determining a witness’s credibility, let alone determining whether a person is guilty or innocent of a crime.”).

37. See D. Michael Risinger, *Whose Fault?—Daubert, the NAS Report, and the Notion of Error in Forensic Science*, 38 FORDHAM URB. L.J. 519 (2010).

that this factor was not an essential condition for admissibility.³⁸ In other words, while relevant, the absence of citations from peer-reviewed journal articles on the method and underlying techniques is not dispositive of whether the expert testimony is admissible. But when there is citation to reliable, peer-reviewed publications available, the court's accounting would be influenced accordingly.

The fourth *Daubert* factor incorporates *Frye*'s "general acceptance" concept. While no longer conclusive, a lack of general acceptance should leave a judge skeptical of the underlying method.³⁹ Furthermore, under this *Daubert* factor, some trial courts have expressed concern over whether the group espousing "general acceptance" also has the proper scientific expertise to evaluate the underlying merits of its position.⁴⁰

Following *Daubert*, the Court further developed its position on expert testimony in *General Electric Company v. Joiner*.⁴¹ *Joiner* addressed the standard at which an appellate court reviews a trial court's findings on the admissibility of expert evidence. *Joiner* held that the standard of review is "abuse of discretion."⁴²

Joiner also expounded on a principle established in *Daubert*, which held that admission of expert evidence should be based exclusively on the underlying "principle[s] and methodology[ies], not on the conclusions that they generate."⁴³ *Joiner*, did not interpret this statement to limit the analysis of expert reliability required of the judge. Rather, *Joiner* concluded that the trial judge is not obligated to admit evidence that is only connected to the scientific data by the expert's unproven statements.⁴⁴ Resolving these two seemingly contradictory holdings can be best understood through Federal Rule 702's prerequisite that the expert reliably apply "the principles and methods to the facts of the case."⁴⁵ Therefore, the trial judge's focus must be twofold: assess the reliability of the underlying principles and methodologies while also assessing the reliability of the application of those principles and methodologies to the case before the court.

After *Joiner*, *Daubert*'s holding was advanced further when the Supreme Court decided *Kumho Tire Co. v. Carmichael*.⁴⁶ *Kumho Tire* held that "[t]here is no clear line that divides the one from the others" when deciding whether to apply a different standard to expert testimony based on science (as in *Daubert*), versus expert testimony based on specialized nonscientific or technical knowledge.⁴⁷ After *Kumho*

38. *Daubert*, 509 U.S. at 593–94.

39. *Id.* at 594.

40. *See, e.g.*, *United States v. Horn*, 185 F. Supp. 2d 530, 557 (D. Md. 2002) ("However skilled law enforcement officials, highway safety specialists, prosecutors and criminologists may be in their fields, the record before me provides scant comfort that these communities have the expertise needed to evaluate the methods and procedures underlying human performance tests such as the [standard field sobriety tests].").

41. *Gen. Elec. Co. v. Joiner*, 552 U.S. 136 (1997).

42. *Id.* at 136.

43. *Daubert v. Merrell Dow Pharmaceuticals, Inc.*, 509 U.S. 579, 595 (1993).

44. *Joiner*, 552 U.S. at 146 ("[N]othing 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.").

45. FED. R. EVID. 702(d).

46. *Kumho Tire Co., Ltd. v. Carmichael*, 526 U.S. 137, 138 (1999).

47. *Id.* at 148.

Tire, *Daubert*'s requirements applied equally to expert testimony based on neuroscience, accounting, DNA typing, or best roofing practices. While the application of *Daubert* to technical expert evidence is the most recognized aspect of *Kumho Tire*, the opinion also notably provides a fifth factor to possibly consider when evaluating expert evidence. *Kumho Tire*'s additional element addresses whether the expert has employed "the same level of intellectual rigor" in the courtroom as an expert in relevant field would employ.⁴⁸

With *Daubert*, *Joiner*, and *Kumho Tire* in place, the trilogy of admissibility requirements for expert evidence was set and soon codified in Rule 702, later restyled to read that:

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.⁴⁹

In 2000, the Advisory Committee Notes to the Federal Rule 702 amendments specifically add that "[n]o attempt has been made to 'codify' [the four specific *Daubert* factors]. And *Daubert* itself emphasized that the factors were neither exclusive nor dispositive. Other cases have also recognized that not all of the specific *Daubert* factors can apply to every type of expert testimony."⁵⁰ The Committee Notes also cite five additional factors which were compiled from various pieces of case law. The notes state as follows: (1) whether the underlying scientific knowledge grew from the expert's work outside of the litigation; (2) whether the expert "unjustifiably extrapolated from an accepted premise to an unfounded conclusion;" (3) whether a differential diagnosis was done or whether alternative explanations were taken into account; (4) whether the expert was "being as careful as he would be in his regular professional work outside his paid litigation consulting;" and (5) whether the general field of expertise being relied upon has a reputation for reaching reliable results or not.⁵¹

48. *Id.* at 152.

49. FED. R. EVID. 702.

50. FED. R. EVID. 702 app. at 1054 (2012).

51. *Id.* ("(1) Whether experts are "proposing to testify about matters growing naturally and directly out of research they have conducted independent of the litigation, or whether they have developed their opinions expressly for purposes of testifying. *Daubert v. Merrell Dow Pharmaceuticals, Inc.*, 43 F.3d 1311, 1317 (9th Cir. 1995).

(2) Whether the expert has unjustifiably extrapolated from an accepted premise to an unfounded conclusion. *See General Elec. Co. v. Joiner*, 522 U.S. 136, 146 (1997) (noting that in some cases a trial court "may conclude that there is simply too great an analytical gap between the data and the opinion proffered").

(3) Whether the expert has adequately accounted for obvious alternative explanations. *See Claar v. Burlington N.R.R.*, 29 F.3d 499 (9th Cir. 1994) (testimony excluded where the expert failed to consider other obvious causes for the plaintiff's condition). *Compare Ambrosini v. Labarraque*, 101 F.3d 129 (D.C. Cir. 1996) (the possibility of some uneliminated causes presents a question of weight, so long as the most obvious causes have been considered and reasonably ruled out by the expert).

B. The New Mexico Cases

In 1993 the New Mexico Supreme Court adopted *Daubert* in *State v. Alberico*.⁵² Before *Alberico*, New Mexico applied *Frye*'s general acceptance test.⁵³ *Alberico*, addressed whether a scientific expert's opinion on posttraumatic stress disorder (PTSD) could be admitted for the purposes of establishing whether a victim's PTSD symptoms were consistent with evidence of a rape or sexual assault.⁵⁴ The Court of Appeals previously held that it was generally recognized in case law that expert testimony should be barred if it attempts to state that a psychological diagnosis of PTSD demonstrates that the alleged victim was sexually assaulted.⁵⁵ In overturning the Court of Appeals and rejecting *Frye*, the New Mexico Supreme Court held that, "too many courts reference reported case law to determine what is generally accepted in the scientific community."⁵⁶ The New Mexico Supreme Court went on to hold that relying on case law in this way "amounts to finding a consensus in the legal community based on scientific evidence that is sometimes many years old."⁵⁷

First, the court held that PTSD evidence does "rest on the valid scientific premise that victims of sexual abuse exhibit identifiable symptoms."⁵⁸ In reaching that decision, the court relied on the third edition of the Diagnostic and Statistical Manual of Mental Disorders, "basic behavioral psychology," and testimony from both sides that psychologists can pinpoint when PTSD is caused by rape because "different stressors manifest themselves in different symptoms."⁵⁹

After *Alberico*, New Mexico's adoption of the same abuse of discretion standard as the Federal courts was confirmed in *State v. Vigil*.⁶⁰ In *Vigil*, the New Mexico Court of Appeals cited a Tenth Circuit Court of Appeals decision that held, "[o]nce the [trial] court has made a determination on [the admissibility of expert

(4) Whether the expert "is being as careful as he would be in his regular professional work outside his paid litigation consulting." *Sheehan v. Daily Racing Form, Inc.*, 104 F.3d 940, 942 (7th Cir. 1997). See *Kumho Tire Co. v. Carmichael*, 119 S.Ct. 1167, 1176 (1999) (*Daubert* requires the trial court to assure itself that the expert "employs in the courtroom the same level of intellectual rigor that characterizes the practice of an expert in the relevant field").

(5) Whether the field of expertise claimed by the expert is known to reach reliable results for the type of opinion the expert would give. See *Kumho Tire Co. v. Carmichael*, 119 S.Ct.1167, 1175 (1999) (*Daubert*'s general acceptance factor does not "help show that an expert's testimony is reliable where the discipline itself lacks reliability, as for example, do theories grounded in any so-called generally accepted principles of astrology or necromancy."), *Moore v. Ashland Chemical, Inc.*, 151 F.3d 269 (5th Cir. 1998) (en banc) (clinical doctor was properly precluded from testifying to the toxicological cause of the plaintiff's respiratory problem, where the opinion was not sufficiently grounded in scientific methodology); *Sterling v. Velsicol Chem. Corp.*, 855 F.2d 1188 (6th Cir. 1988) (rejecting testimony based on "clinical ecology" as unfounded and unreliable)."

52. *State v. Alberico*, 1993-NMSC-047, 861 P.2d 192.

53. *Id.*

54. *Id.* ¶ 4.

55. *Id.* ¶ 29.

56. *Id.* ¶ 48.

57. *Id.*

58. *Id.* ¶ 80.

59. *Id.*

60. *State v. Vigil*, 1985-NMCA-110, 711 P.2d 920.

opinions], such a decision is accorded great weight by a reviewing court and this decision will be upheld absent an abuse of discretion.”⁶¹ *Vigil* also stands for the proposition that, “[t]he trial court has wide discretion in determining whether a witness is qualified to testify as an expert.”⁶²

This same wide discretion was already protected in New Mexico since at least 1947 when the New Mexico Supreme Court held, “[w]hether an expert witness is qualified to give an opinion is a matter which is peculiarly within the discretion of the trial court, and unless that discretion has been abused this court will not disturb the ruling in refusing such testimony.”⁶³ While New Mexico’s level of appellate review is in line with the Federal practice, the state has developed an interesting split from the Federal courts on non-scientific or technical expert testimony. In *Bustos v. Hyundai Motor Co.*, the New Mexico Court of Appeals declined to adopt a *Kumho Tire*-like application of the *Daubert/Alberico* requirements when specialized or technical testimony is at issue.⁶⁴ In New Mexico, only scientific expert evidence is viewed as requiring a confirmed level of reliability before presenting that testimony to the fact finder.⁶⁵

In addition, New Mexico has been proactive in adding to the non-exhaustive list of *Daubert* factors to be considered when evaluating expert evidence. In *Andrews v. U.S. Steel Corp.*, the New Mexico Court of Appeals added a fifth and possibly sixth factor to the list. The first is whether the technique is based on well-recognized scientific principles. The second is whether the technique is based on reasonable probability rather than conjecture.⁶⁶ So, while *Kumho Tire*’s fifth factor may not have been formerly adopted in New Mexico, the New Mexico Court of Appeals has shown a willingness to expand on the factors to consider when evaluating reliability.

In some cases, New Mexico case law has even laid out specific points of analysis for particular scientific techniques. For example, in regard to polygraph testing, the analysis of reliability for admission must include: (1) whether “the court has evidence of the qualifications of the polygraph operator to establish his expertise;” (2) whether “testimony to establish the reliability of the testing procedure employed . . . [was] . . . approved by the authorities in the field; and (3) “[t]he validity of the tests made on the subject.”⁶⁷ Likewise, hypnosis can be admissible evidence if it passes a unique six-pronged test.⁶⁸ While polygraph and hypnosis have been argued as being the very type of junk science that *Daubert* was intended to exclude,⁶⁹ New Mexico law does provide a lane for their admission.

61. *Id.* ¶ 10.

62. *Id.* (citing *Wood v. Citizens Standard Life Ins. Co.*, 1971-NMSC-011, 480 P.2d 161). *Wood* too held that “[t]he trial court has wide discretion in determining whether one offered as an expert witness is competent or qualified to give an opinion on any given subject or proposition, and the court’s determination of this question will not be disturbed on appeal, unless there has been an abuse of discretion.” *Id.* ¶ 9.

63. *Bunton v. Hull*, 1947-NMSC-005, ¶ 23, 177 P.2d 168.

64. 2010-NMCA-090, 243 P.3d 440.

65. See *Parkhill v. Alderman-Cave Milling and Grain Co. of New Mexico*, 2010-NMCA-110, 245 P.3d 585.

66. *Andrews v. U.S. Steel Corp.*, 2011-NMCA-032, 250 P.3d 887.

67. *State v. Dorsey*, 1975-NMCA-022, ¶ 2, 532 P.2d 912.

68. *State v. Beachum*, 1981-NMCA-137, ¶ 41, 643 P.2d 246.

69. Rakoff, *supra* note 36, at 1382.

II. A NEW WAY OF EVALUATING EXPERT EVIDENCE AND TESTIMONY

Even with an understanding of *Daubert*'s holding in place, the scope of the required reliability assessment remains unsettled. Should the court allow diagnostic opinion testimony go straight to weight and not admissibility, or is *Daubert* larger in scope? Law Professors David Faigman, John Monahan, and Chris Slobogin have proposed a group to individual structure for evaluating expert evidence, abbreviated "G2i," that puts a structure in place to answer that question. G2i differentiates between general framework evidence (G) and individualized diagnostic evidence (i).⁷⁰ Framework evidence is the general, universal scientific principle or theory. Individual evidence is the particular facts of a unique event or circumstance that are then applied to the general theory or principle.

Another way to describe the breakdown of evidence into the two G2i subtypes is to consider group level or framework evidence as the empirical scientific knowledge of which the individual-level evidence in a particular case might be a specific example.⁷¹ Individual-level evidence, or diagnostic evidence, in turn, is the specific example or the application of the group-level, empirical scientific knowledge to individual facts.⁷² To illustrate this point, take the example of an x-ray. The scientific knowledge underlying an x-ray, the technology and testing that made it possible, and the principles that let us feel confident that the images radiologists see on the film are in fact reliable illustrations of bone is framework evidence. However, a radiologist diagnosing a broken clavicle from those images (i.e. the application of that data to the specific individual films in question) is an example diagnostic evidence.

Through the G2i lens it is clear that *Daubert* hearings require judges to "regularly decide how case specific to allow an expert to get."⁷³ As described earlier, *Joiner* held that when a judge does allow an expert to provide specific or diagnostic evidence, the same reliability analysis must be applied to the diagnostic evidence as was applied to the framework evidence.⁷⁴ *Kumho Tire* similarly stressed that the reliability of all evidence—framework and diagnostic—must be evaluated under *Daubert*, holding, "where such testimony's factual basis, data, principles, methods, or their application are called sufficiently into question" a determination over whether there is a reliable basis for that testimony must be made.⁷⁵ It is up to the judge to then determine if the support presented is adequate enough to meet the reliability threshold for "framework [i.e. general] evidence alone or framework evidence coupled with particularized proof [i.e. individual evidence.]"⁷⁶

70. See Faigman, Monahan & Slobogin, *supra* note 3, at 420.

71. *Id.* at 417.

72. *Id.* at 419.

73. *Id.* at 426.

74. See *Gen. Elec. Co. v. Joiner*, 552 U.S. 136, 146 (1997) ("[N]othing 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.").

75. *Kumho Tire Co., Ltd. v. Carmichael*, 526 U.S. 137, 149 (1999).

76. Faigman, Monahan & Slobogin, *supra* note 3, at 432.

Applying the *Daubert* factors to framework evidence is relatively straightforward, and courts have done and continue to review framework evidence regularly. Likewise, the four *Daubert* factors can also be applied directly to diagnostic evidence. Applying *Daubert* to diagnostic evidence is inherently more difficult and sometimes can only be done with varying levels of success.

In regard to the testability factor, diagnostic evidence is best evaluated when the presence of “feedback loops” are identified.⁷⁷ Proficiency tests or proof verification methods such as recalibration or renorming processes are examples of feedback loops. If it is the expert herself whose diagnosis is being evaluated, then feedback loops can be increasingly difficult to find. However Faigman, Monahan, and Slobogin point out that, “a diagnostic expert can at least attend to the *process* of accumulating and analyzing the relevant information” needed to assess the validity of the diagnosis even if recreating the initial condition is impossible.⁷⁸

Error rates of diagnostic evidence are typically easier to find and evaluate. As illustrated in *Kumho Tire*’s recommendation that a judge ask “how often an engineering expert’s experience-based methodology has produced erroneous results. . . .”⁷⁹ If an expert does not keep track of his own success rate, that too should be information the judge relies on when assessing the reliability of the diagnostic evidence. And in cases when it is impossible to track the success or error rate of the individual application, courts can assess whether the best practices or adequate standards laid out by the relevant scientific community were actually practiced by the expert offering the diagnostic evidence.⁸⁰

When it comes to evaluating diagnostic evidence through the peer review or publication factor, the most readily available form of peer review would be the concurrence of a second opinion. Faigman, Monahan, and Slobogin caution, however, that a valid second opinion should not be a mere rubber stamp by a colleague.⁸¹ A blind second opinion, where the second expert has no knowledge of the first expert’s review, would present the option for better validity in such a case.⁸²

Finally, the application of the general acceptance factor to diagnostic evidence can be evaluated by considering if the testifying expert “employed the accepted protocol in the approved manner” as developed by an independent body.⁸³ These accepted protocols should be based on the best practices as developed through scientific study. In cases where no independent body has studied and developed the best practices for application of the scientific information to individual facts, Faigman, Monahan, and Slobogin again turn to *Kumho Tire* for the instruction that the court should evaluate whether the diagnostic expert’s “preparation is of a kind that others in the field would recognize as acceptable.”⁸⁴

77. *Id.* at 451.

78. *Id.* at 452 (using the example of a psychiatric diagnosis of insanity can never be evaluated for whether it is correct or not).

79. *Id.* at 455 (citing *Kumho Tire*, 526 U.S. at 151).

80. Faigman, Monahan & Slobogin, *supra* note 3, at 455.

81. *Id.* at 459.

82. *Id.*

83. *Id.* at 462.

84. *See id.* (citing *Kumho Tire*, 526 U.S. at 151).

As courts more widely adopt the “same intellectual rigor” factor from *Kumho Tire* or, in New Mexico at least, the “well-recognized scientific principles” and “reasonable probability rather than conjecture” factors from *Andrews*, a similar analysis of the ways in which those factors should be applied to diagnostic evidence can be conducted.

III. LOOKING BACK: THE ADMISSION OF DNA EVIDENCE

It did not take long for Dr. Alec Jeffreys’s discovery—that all individuals (with the exception of identical twins) have a unique genetic fingerprint that can be identified through testing of biological material—to make its way into the legal system.⁸⁵ The technology was first used in England to identify the killer of two teenage girls.⁸⁶ DNA testing has now come to be considered routine and even expected evidence in cases where subject identification is at issue. It is standard practice for DNA samples to be collected from crime scenes and sent to laboratories for comparison analyses in the hopes of identifying the suspect or matching a defendant to the crime. Unfortunately, there have also been numerous examples of poorly run laboratories that engage in sloppy practices as well as even more egregious examples of technicians deliberately contaminating evidence and providing inaccurate results.⁸⁷ It is likely impossible to predict such bad actors that intentionally falsify results and deceive their colleagues, supervisors, and the courts. There are ways, however, to reduce the likelihood that such behaviors occur and remain undiscovered and unchecked for years. Requiring that diagnostic DNA evidence undergo a full *Daubert* admissibility analysis, is one such way.

A. Admissibility of DNA evidence in New Mexico

At the time *Alberico* was decided, another New Mexico case had already been argued that would be among the first reviewed under the new *Alberico* standard. That case, *State v. Anderson*, involved the admissibility of DNA analysis conducted by the Federal Bureau of Investigation (FBI).⁸⁸ The expert opinions in *Anderson* were originally qualified and admitted at trial under *Frye*, then reviewed and reversed by the New Mexico Court of Appeals using a *Frye* analysis, and finally admitted by the New Mexico Supreme Court after application under the new *Alberico* standard.⁸⁹

85. Alec Jeffreys, Victoria Wilson & Swee Lay Thein, *Hypervariable ‘Minisatellite’ Regions in Human DNA*, 314 NATURE 67, 67 (1985); see also Peter Gill, Alec J. Jeffreys & David J. Werrett, *Forensic Application of DNA ‘Fingerprints’*, 318 NATURE 577–579 (1985).

86. Jay D. Aronson, *DNA Fingerprinting on Trial: The Dramatic Early History of a New Forensic Technique*, 29 ENDEAVOUR 126, at 130 (2005).

87. See Katie Worth, *Crime Lab Scandals the Focus of New DOJ Plan*, FRONTLINE, PBS.ORG (Dec. 8, 2015), <http://www.pbs.org/wgbh/frontline/article/crime-lab-scandals-the-focus-of-new-doj-plan/>; Seattle Post-Intelligencer Staff, *DNA Testing Mistakes at the State Patrol Crime Labs*, SEATTLE POST-INTELLIGENCER, Jul. 21, 2004, <http://www.seattlepi.com/local/article/DNA-testing-mistakes-at-the-State-Patrol-crime-1149846.php>; Brendan J. Lyons, *Scientists Suspended as State Police DNA Scandal Deepens*, TIMESUNION, Apr. 12, 2015, <http://www.timesunion.com/news/article/Scientists-suspended-as-State-Police-DNA-scandal-6194258.php>.

88. 1994-NMSC-089, 881 P.2d 29.

89. *Id.* ¶ 1.

The challenge to the FBI's testing was that the DNA matching and statistical method used to determine the probability of a random match between the known sample and tested sample was not generally accepted.⁹⁰ At the time the FBI's DNA typing, where a segment of DNA is matched between two samples, was done using the restriction fragment length polymorphism (RFLP) method of analysis. RFLP analysis is conducted by looking at the lengths and variations of specific, short segments of DNA that are naturally cut by restriction enzymes.⁹¹ When these short sequences are matched between two samples, it "does not mean that the suspect was definitely the source of the genetic material found at the crime scene, however, but simply that the suspect cannot be eliminated as the potential source. Even if there is a perfect match, there is a possibility that the two samples came from different people whose DNA patterns at the targeted loci are indistinguishable."⁹²

In review of the technique's reliability, the New Mexico Supreme Court held that the RFLP method employed did meet the first, second, and fourth *Daubert* factors (the method had been tested, the method was subject to peer review and publication, and the method was generally accepted in the scientific community). It was the third factor that raised the most concern: namely the method's error rate.⁹³

The court first held that the FBI did fail to calculate the rate of error and failed to conduct a blind proficiency test in its DNA typing procedure.⁹⁴ However, the Court said such deficiencies went to the weight of the evidence not to its admissibility.⁹⁵ Likewise the court noted that the statistical potential for error in the method used by the FBI creates a controversy.⁹⁶ The defendant had argued that the sample population the FBI relied on for its statistical analysis, which resulted in the likelihood that the DNA would match an unrelated individual in the population at 1 in 6.2 million, did not represent the true population and therefore was flawed.⁹⁷ In order to truly test the likelihood of two unrelated samples matching, a sample group of "ethnically distinctive subgroups"⁹⁸ would be required as opposed to the FBI's forensic sample group of 225 agent-trainees.⁹⁹ After acknowledging the controversy, the New Mexico Supreme Court held that this alleged discrepancy went to the weight of the evidence and not its admissibility.¹⁰⁰ The Court then addressed subsequent trial courts, directing them to, "only examine whether the principles and methodology used are scientifically valid and generally accepted. The assessment of the validity and reliability of the conclusions drawn by the experts, however, is a jury question."¹⁰¹

90. *Id.* ¶ 56.

91. *RFLP Analysis*, <http://www.uvm.edu/~cgep/Education/RFLP.html> (last visited Apr. 22, 2016).

92. *Anderson*, 1994-NMSC-089, ¶ 12.

93. *Id.* ¶ 15.

94. *Id.* ¶ 47.

95. *Id.*

96. *Id.* ¶ 57.

97. *Id.*

98. *Id.*

99. *Id.* ¶ 12.

100. *Id.* ¶ 58.

101. *Id.* ¶ 59.

The next case to address the admission of DNA evidence was *State v. Stills*,¹⁰² the first case in NM to allow polymerase chain reaction (PCR) method of DNA analysis into court, which is different from the RFLP method at issue in *Anderson*. In practice, the RFLP method has been largely supplanted by the less reliable, but faster and more sensitive PCR method. Anthony Stills, the defendant in a felony murder, child abuse, first-degree criminal sexual penetration, kidnapping, and tampering with evidence case challenged the admission of the results of a PCR method DNA test by arguing that the PCR method does not meet the testability, error rate, and general scientific acceptance of the *Daubert/Alberico* factors.

Ultimately, the New Mexico Supreme Court affirmed the trial court's admission of the PCR method and disagreed with the defendant's arguments relating to all three factors.¹⁰³ The defendant's experts had argued that results from the PCR method were inconclusive and unacceptable, and that such problems spoke to the underlying reliability of the test itself as evidence, not just to the weight of that evidence.¹⁰⁴ The court disagreed and in addressing the underlying reliability versus weight argument, held that "[a] technique is valid if it produces accurate results . . . and if it produces the same results time and time again."¹⁰⁵ Because the PCR analysis has been subjected to "countless number[s] of tests and experiments" in the nearly 15 years since it had been discovered, the court found the reliability bar was met.¹⁰⁶ The court avoided the pitfall of discussing the distinction between what evidence goes to weight and what evidence goes to admissibility by citing the PCR method's long history of reaching the same results when tested.¹⁰⁷

In regard to the error rate analysis, as in *Anderson*, the defendant argued that the lack of external blind proficiency testing at the lab in question speaks to technique's unreliability under the *Daubert* error rate factor.¹⁰⁸ The New Mexico Supreme Court, however, agreed with its earlier holding in *Anderson* and held that any arguments about the statistical calculations go to the weight of the evidence.¹⁰⁹ At trial, both the defendant's experts and a former worker at the lab that conducted the PCR analysis testified that there was a flaw in the calculations being used.¹¹⁰ That testimony, the Court held, should go to the jury "to determine what weight to give the PCR results in this case."¹¹¹

B. Admissibility of DNA Evidence in other jurisdictions

New Mexico is far from alone in addressing challenges to the admissibility of DNA evidence. In the Eighth Circuit case of *United States v. Beasley*, the defendant was convicted of armed robbery of a bank and, argued that DNA evidence

102. 1998-NMSC-009, ¶ 23, 957 P.2d 51.

103. *Id.* ¶ 56.

104. *Id.* ¶ 19.

105. *Id.* ¶ 29.

106. *Id.*

107. *Id.*

108. *Id.* ¶ 31.

109. *Id.*

110. *Id.*

111. *Id.*

placing him in the getaway car should be excluded.¹¹² DNA from two hairs found in a ski mask that was left in a getaway car was matched to the defendant's DNA using the PCR method.¹¹³ The defense argued that the PCR method did not meet the *Daubert* standard generally.¹¹⁴ In the alternative, the defense argued that even if the PCR method did meet the court's standard of reliability, the "protocol and procedures" at the lab that conducted the testing were not adequate" enough to be deemed reliable.¹¹⁵

The argument under the alternative defense was based on the lab's failure to observe the special precautions required when doing PCR testing.¹¹⁶ Namely, it failed to conduct frequent external proficiency testing of the lab technicians, failed to conduct double blind tests to check results, and failed to maintain error records.¹¹⁷ Beasley held that the alleged failures go to weight, not admissibility because "[a]n allegation of failure to properly apply a scientific principle should provide the basis for exclusion of an expert opinion only if a reliable methodology was so altered . . . as to skew the methodology itself."¹¹⁸

Beasley further held that the PCR method has now been established to the point that future trial courts could take judicial notice of its reliability.¹¹⁹ In taking judicial notice of PCR testing, the court did not foreclose challenges to the individual application of PCR tests "by showing that a scientifically sound methodology has been undercut by sloppy handling of the samples, failure to properly train those performing the testing, failure to follow the appropriate protocols, and the like."¹²⁰

C. Analysis of DNA when Applying G2i

As has been well noted, experts testifying to DNA matching evidence do not typically offer a conclusion on whether the DNA sample in question matches an individual subject's sample. "Instead, DNA experts . . . insist on general probability statements regarding the likelihood of finding the "match" randomly in the population.¹²¹ In addition, DNA diagnostic protocols, which calculate the chances of finding a match in the population, can be tested at the diagnostic or individual level. Specifically, individual profiles derived through the PCR method (as described in *Stills*) "can be tested and retested by cross-validating [those profiles] on new sample populations."¹²²

In addition to cross-validation of the diagnostic evidence described above, the court should evaluate if the lab that conducted the analysis has met the threshold level of reliability necessary to admit diagnostic evidence. To assess the testability

112. 102 F.3d 1440, 1443–44 (8th Cir. 1996).

113. *Id.* at 1444.

114. *Id.* at 1445.

115. *Id.*

116. *Id.* at 1448.

117. *Id.*

118. *Id.* (internal citations omitted).

119. *Id.*

120. *Id.*

121. Faigman, *supra* note 3, at 438.

122. *Id.* at 456.

factors, the question should be raised as to whether the lab has a process for collecting and analyzing the samples. Additionally, asking if the lab tracks its past record of erroneous matches, and if so what that rate is, can be an acceptable application of error rate analysis.¹²³ And finally, it should be noted whether the lab routinely follows, and has followed in the case at hand, the accepted protocols of an independent oversight body such as those that have recently been required by the Department of Justice.¹²⁴

In contrast, *Anderson*, *Stills*, and *Beasley* are examples of courts willing to forego an analysis of the diagnostic evidence's reliability, and instead, pass the burden of conducting that analysis to the fact finder. *Anderson* did, in fact, hold that the FBI had failed to calculate an error rate, and that no blind proficiency testing was conducted. In addition, the potential for a flaw in the statistical analysis was raised.¹²⁵ Yet, the New Mexico Supreme Court held that analysis of each of these details should be considered by the jury in regard to the weight of the evidence, and, by extension, that these issues did not bear on the underlying reliability of the conclusion matching the defendant's DNA to the sample.¹²⁶

Despite *Still*'s holding that "[a] technique is valid if it produces accurate results,"¹²⁷ the court did not view the flaws in the lab's calculations as a enough of a factor to call into question whether the diagnostic evidence met the reliability benchmark. Likewise, *Beasley* did not find the lab's failure to conduct proficiency testing, failure to conduct double-blind tests, and failure to maintain error records as enough to question if the diagnostic application failed to meet a benchmark level of reliability. This failure to assess if diagnostic evidence is applied reliably goes against *Joiner*'s warning to not admit diagnostic evidence based solely on the *ipse dixit* of an expert.¹²⁸

IV. MOVING FORWARD: THE LAW AND NEUROSCIENCE MOVEMENT

A few recent works have highlighted the large number of criminal cases across the country that have involved neuroimaging evidence in recent decades. One of the studies, published in February 2016, catalogs over 1,600 criminal cases that involved "neuro" themed evidence (as well as behavioral genetics evidence) and testimony. The study found that this type of evidence more than doubled between 2005 and 2012.¹²⁹ While those cases include much broader evidence than just neuroimaging, the study highlights the fact that this type of scientific evidence is increasingly proffered. This is because it was either collected during the course of medical treatment or it was sought out in relation to the litigation.

123. *Id.* (adding that when a lab does not track its erroneous matches, inquiring whether the lab follows the best practices when conducting its testing, can then be used to evaluate the error rate factor).

124. U.S. DEP'T OF JUSTICE, OFFICE OF PUB. AFFAIRS, <https://www.justice.gov/opa/pr/justice-department-announces-new-accreditation-policies-advance-forensic-science> (last visited Apr. 27, 2016).

125. *State v. Anderson*, 1994-NMSC-089, ¶ 47, 881 P.2d 29.

126. *Id.* ¶ 58.

127. *State v. Stills*, 1998-NMSC-009, ¶ 29, 957 P.2d 51.

128. *Gen. Elec. Co. v. Joiner*, 522 U.S. 136, 145 (1997).

129. Nita A. Farahany, *Neuroscience and Behavioral Genetics in US Criminal Law: An Empirical Analysis*, 2 J.L. & BIOSCIENCES 485 (Nov. 2015).

A study published in 2014 found that not only was neuroimaging evidence offered in a surprisingly large number of cases between 1990 and 2012, it was the foundation for a number of successful ineffective assistance of counsel claims.¹³⁰ A number of criminal defendants were able to succeed with their claims because counsel failed to adequately investigate the defendant's overall mental health, whether the defendant had brain damage, and failed to pursue, obtain, and present neuroimaging evidence, which reasonably could have resulted in a different outcome.¹³¹ Continuing the analysis of neuroimaging data in criminal court, the most recent survey reveals the trends continue to reflect an increasing request for and proffer of neuroimaging related evidence, with more than 100 reported appellate cases involving this type of evidence between 2013 and 2015.¹³²

In terms of admissibility, there are a number of cases across the county where the court declined to admit neuroimaging evidence and cited failure to pass *Frye* or *Daubert* as a reason.¹³³ In order to understand those cases it is important to be aware of two points. First, the different neuroimaging techniques, such as Magnetic Resonance Imaging (MRI), Computerized Tomography (CT), Electroencephalography (EEG), Positron Emission Tomography (PET), and Single Photon Emission Computed Tomography (SPECT), all use different methodology. Each technique can also have varying levels of sensitivity and specificity in relation to different findings. As a result, each technique and each finding cannot and should not be lumped together in a single reliability analysis. Second, the most frequently-cited reason a neuroimaging technique is not admitted is when the diagnostic claims made by the expert are not supported in the corresponding scientific literature.¹³⁴ In order to understand the differences among techniques, a brief overview of neuroscience and neuroimaging techniques follows. That overview is then supplemented by a short history of cases involving neuroimaging evidence, providing context for the modern *Daubert* analysis of neuroimaging evidence.

130. Deborah W. Denno, *The Myth of the Double-Edged Sword: An Empirical Analysis of Neuroscience Evidence in Criminal Cases*, 56 B.C. L. REV. 493, 499 (2015); see also Strickland v. Washington, 466 U.S. 668, 687–92 (discussing the two-pronged test for ineffective assistance of counsel that requires counsel to have been “deficient” as well as the defendant to be “prejudiced”).

131. *Id.* at 508 (explaining “nearly all successful *Strickland* claims were based on an attorney’s failure to appropriately investigate, gather, or understand neuroscience evidence—as opposed to any one of a number of other types of ineffective assistance of counsel claims that the Neuroscience Study recorded”).

132. Lyn M. Gaudet & Gary E. Marchant, *Under the Radar: Neuroimaging Evidence in the Criminal Courtroom*, 64 DRAKE L. REV. (forthcoming 2016) (manuscript on file with authors).

133. See, e.g., *People v. Hix*, No. B203884, 2009 WL 242318 (Cal. App. 2009) (refusing to admit SPECT scan evidence because technique is not generally accepted in the neurological community for showing brain damage, but only for diagnosing dementia, epilepsy, and seizures).

134. See, e.g., *People v. Yum*, 3 Cal. Rptr. 3d 855, 856–57 (Cal. Ct. App. 2003) (holding that the trial court did not err in excluding SPECT data and corresponding expert testimony under *Frye* because SPECT scan to diagnose PTSD and brain trauma is not generally accepted in the field of brain imaging and neurology).

A. Neuroscience and neuroimaging techniques

Neuroscience can be described as the study of the brain in health and disease.¹³⁵ Neuroscientists use a range of imaging techniques, collectively referred to as neuroimaging, to study the human brain *in vivo* and how both brain structure and function contribute to everything from sensation and perception to cognition and behavior.¹³⁶ Neuroscience and associated disciplines are rapidly growing as an increasing number of scientists around the world believe understanding the brain is key to understanding the human condition.¹³⁷

Neuroimaging and neurophysiology techniques can be divided into two main categories, structural and functional. Structural imaging methods include CT and MRI. CT was one of the first techniques used to look inside the brain.¹³⁸ It uses X-rays to generate images of the entire body and internal organs.¹³⁹ It is most frequently used to look for infarction, tumors, hemorrhage, and bone trauma.¹⁴⁰ MRI uses magnetic fields to exploit the different physical properties between organs, tissue, and bone that appear in various shades of white, black, and gray, respectively.¹⁴¹ From a clinical perspective MRI is the most frequently used imaging test to evaluate the brain and spinal cord.¹⁴² Because MRI can take higher resolution images, the difference between normal and abnormal tissue is often more clear on an MRI than a CT.¹⁴³ Consequently, MRI is the preferred method when seeking data related to lesions, atrophy, vascular disease, and intracranial pressure disorders.¹⁴⁴ An additional benefit of MRI is that it does not require radiation exposure like CT,

135. *Neuroscience* Definition, DICTIONARY.COM, <http://www.dictionary.com/browse/neuroscience?s=t> (defining neuroscience as “the field of study encompassing the various scientific disciplines dealing with the structure, development, function, chemistry, pharmacology, and pathology of the nervous system”) (last visited Apr. 27, 2016).

136. See, e.g., RICHARD B. BUXTON, INTRODUCTION TO FUNCTIONAL MAGNETIC RESONANCE IMAGING: PRINCIPLES AND TECHNIQUES 7 (2nd ed. 2009); Joy Hirsch et al., *An Integrated Functional Magnetic Resonance Imaging Procedure for Preoperative Mapping of Cortical Areas Associated with Tactile, Motor, Language, and Visual Functions*, 47 NEUROSURGERY 711 (2000).

137. See, e.g., Catriona D. Good et al., *A Voxel-Based Morphometric Study of Ageing in 465 Normal Adult Human Brains*, 14 NEUROIMAGE 21, 21 (2001); J. C. Baron et al., *In Vivo Mapping of Gray Matter Loss with Voxel-Based Morphometry in Mild Alzheimer’s Disease*, 14 NEUROIMAGE 298, 298 (2001); Massimo Filippi & Federica Agosta, *Structural and Functional Network Connectivity Breakdown in Alzheimer’s Disease Studied with Magnetic Resonance Imaging Techniques*, 24 J. ALZHEIMER’S DISEASE 455, 456 (2011); Robyn Honea et al., *Regional Deficits in Brain Volume in Schizophrenia: A Meta-Analysis of Voxel-Based Morphometry Studies*, 162 AM. J. PSYCHIATRY 2233 (2005); Thomas Nickl-Jockschat et al., *Brain Structure Anomalies in Autism Spectrum Disorder—A Meta-Analysis of VBM Studies Using Anatomic Likelihood Estimation*, 33 HUM. BRAIN MAPPING 1470 (2012).

138. See generally Michel M. Ter-Pogossian, *Basic Principles of Computed Axial Tomography*, 7 SEMINARS IN NUCLEAR MEDICINE 109 (1977).

139. *Id.*

140. *Id.*

141. See PHILIPPA TYLER AND SAJID BUTT, RADIONUCLIDE AND HYBRID BONE IMAGING 150 (Ignac Fogelman et al. eds., 2012).

142. *Id.* at 149.

143. *Id.*

144. *Id.*

nor require the use of a radioactive tracer, like positron emission tomography (PET) and single-photon emission computerized tomography (SPECT).¹⁴⁵

Functional imaging methods include electroencephalography (EEG), magnetoencephalography (MEG), positron emission tomography (PET), single photon emission computed tomography (SPECT), and functional magnetic resonance imaging (fMRI). Brain cells encode information in the form of time-varying electromagnetic signals, with information passed from one cell to the next through a chemical transduction mechanism involving neurotransmitters.¹⁴⁶ When brain cells are progressively active, there is an increase in the local metabolic demand, and a related increase in regional blood flow to bring oxygenated blood to the active neurons.¹⁴⁷ Different functional imaging methods assess different aspects of this overall cascade.

EEG and MEG directly measure the electromagnetic activity of the brain.¹⁴⁸ Currents flowing within neurons give rise to electrical potential gradients on the scalp surface (which are measured by EEG) and magnetic flux (which is measured by MEG).¹⁴⁹ EEG is accomplished through the use of scalp attached electrodes, whereas MEG uses non-contact super-cooled sensors arrayed about the head.¹⁵⁰ These methods provide a real-time direct measure of neuronal activity on the scale of milliseconds.¹⁵¹ In the clinic, EEG and MEG can be used to assess mental state, identify abnormal epileptiform activity, identify abnormal slow wave activity (a signature of dysfunctional brain tissue), and to look at functional interactions between brain regions.¹⁵² Signal averaging methods that generate event-related potentials and fields can be used to localize functional regions (e.g., motor cortex) and to track information flow within the brain in both space and time.¹⁵³

PET and SPECT can be used to evaluate brain metabolism, blood flow, and chemistry, using select radioactive tracers.¹⁵⁴ For example, certain PET tracers bind to the receptors for specific neurotransmitters, so it is possible to assess the distribution of, for example, dopamine receptors in control subjects and patients with schizophrenia.¹⁵⁵ Other tracers like the PET ligand 2-fluoro-deoxyglucose, allow for assessment of regional brain, while compounds like the SPECT tracer Tc-HMPAO

145. *Id.*

146. *See, e.g.*, MARK DUBIN, *HOW THE BRAIN WORKS* (Lauren Sompayrac ed., 2013).

147. *See* RICHARD B. BUXTON, *INTRODUCTION TO FUNCTIONAL MAGNETIC RESONANCE IMAGING* 7 (2d ed. 2009).

148. *See generally* Daniel M. Goldenholz et al., *Mapping the Signal to Noise Ratios of Cortical Sources in Magnetoencephalography and Electroencephalography*, 30 *HUM. BRAIN MAPPING* 1077 (2009).

149. *Id.*

150. *Id.*

151. *Id.*

152. *Id.*

153. *Id.*

154. *See generally* *POSITRON EMISSION TOMOGRAPHY AND AUTORADIOGRAPHY: PRINCIPLES AND APPLICATIONS FOR THE BRAIN AND HEART* (Michael E. Phelps, Je Mazziotta & Heinrich R. Schelbert eds., 1986) [hereinafter PHELPS, MAZZIOTTA & SCHELBERT].

155. *See, e.g.*, Yoshiro Okubo et al., *Decreased Prefrontal Dopamine D1 Receptors in Schizophrenia Revealed by PET*, 385 *NATURE* 634 (1997).

allow for measurement of regional cerebral blood flow.¹⁵⁶ In general, nuclear medicine methods provide relatively good spatial resolution (cm), but poor temporal resolution (tens of seconds) of neurobiological processes. These methods have high clinical utility in exploration of conditions like cancer, epilepsy, stroke, and dementia.¹⁵⁷

Functional MRI (fMRI) is used to measure the magnetic properties of blood as it moves to specific regions. Oxygenated blood can be distinguished from deoxygenated blood and, thus, it is possible to measure when a region is being activated as more oxygenated blood is delivered.¹⁵⁸ Thus, fMRI allows the examiner to evaluate regional hemodynamics at rest, functional relationships between brain regions, and responses to sensory, motor, and cognitive events.¹⁵⁹ Importantly, fMRI (like structural MRI) does so without any need of a radioactive tracer, so imaging can be easily repeated on the same subject in a risk free manner.¹⁶⁰ fMRI can provide sub-centimeter spatial resolution with fair temporal resolution.¹⁶¹ And fMRI is especially useful for evaluation of complex cognitive processes like memory, emotion, and attention.¹⁶² In clinical settings, fMRI is often used for pre-surgical localization of functional regions (e.g., language cortex, motor cortex) in epilepsy and tumor patients.¹⁶³ It is also used in clinical research for exploration of a wide range of conditions including psychiatric disease, dementia, traumatic brain injury, and developmental and learning disabilities.¹⁶⁴

Like other scientific disciplines, neuroimaging data collection and analysis methods have seen considerable technological advances in the past decade. Scientists are now employing a multi-modal approach, where they combine multiple data collection techniques and the related findings. Further, analysis methods such as voxel based morphometry (VBM),¹⁶⁵ where the brain is divided into a multitude of cubes and each cube's density and volume is measured, are now routinely used. As is independent component analysis (ICA), a statistical method that can find hidden features among large data sets.¹⁶⁶ Together VBM and ICA, and other analysis techniques have allowed scientists to gain new insight into brain structure and function and how those interact through what is referred to as resting state networks

156. Jong Jin Lee et al., *Diagnostic Performance of ¹⁸F-FDG PET and Ictal ^{99m}Tc-HMPAO SPET in Pediatric Temporal Lobe Epilepsy: Quantitative Analysis by Statistical Parametric Mapping, Statistical Probabilistic Anatomical Map, and Subtraction Ictal SPET*, 14 SEIZURE 213 (2005).

157. See PHELPS, MAZZIOTTA & SCHELBERT, *supra* note 158.

158. See BUXTON, *supra* note 151.

159. *Id.*

160. *Id.*

161. *Id.*

162. *Id.*

163. *Id.*

164. See TYLER & BUTT, *supra* note 145.

165. See, e.g., STATISTICAL PARAMETRIC MAPPING: THE ANALYSIS OF FUNCTIONAL BRAIN IMAGES 92 (Karl. J. Friston et al. eds., 2011) (discussing that neuroimaging groups across the country and around the world use VBM as a reliable and reproducible way to measure brain volume from neuroimaging data); J. C. Baron et al., *supra* note 141, at 298 (“[VBM] is a whole-brain, unbiased technique for characterizing regional cerebral volume and tissue concentration differences in structural magnetic resonance images.”).

166. V.D. Calhoun, J. Liu & T. Adalic, *A Review of Group ICA for fMRI Data and ICA for Joint Inference of Imaging, Genetic, and ERP Data*, 45 NEUROIMAGE S163 (2009).

and functional network connectivity.¹⁶⁷ These methods are being applied to a wide range of medical, developmental, and psychiatric conditions and the peer-reviewed published literature on these techniques will continue to grow.¹⁶⁸

B. The Beginning of the Law and Neuroscience Movement

The trial of John Hinkley Jr.¹⁶⁹ is often referred to as the first case where neuroimaging data was proffered as evidence relating to a defendant's mental health condition. While it may be one of the first times such data was used to provide imaging findings consistent with a psychiatric diagnosis, it was not the first time that imaging data was collected in relation to a criminal trial. Seven years earlier in the case of *Meredith v. State* a defendant attempted to admit EEG and X-Ray evidence to support the existence of brain damage that would, in turn, support a claim of insanity.¹⁷⁰ This evidence was admitted but the court found that the data, along with neuropsychological testing, did not show evidence of brain damage that indicated diminished capacity or insanity.¹⁷¹ The court denied his appeal and explained that insanity was a question of fact and that the jury's verdict was appropriate.¹⁷²

In the 1978 case of *United States v. Erskine* the defendant sought to admit brain scan evidence and expert testimony to establish that he was unable to form the specific intent required to violate 18 U.S.C. § 1014 (i.e. making a false statement for the purpose of influencing a bank).¹⁷³ The trial court excluded the evidence but the appellate court found the defendant's brain scan evidence was improperly denied admission.¹⁷⁴ The court stated, "[w]e express no opinion on whether Dr. Saiddy was qualified to give such an opinion on the defendant's mental condition, but we do hold that the defendant was entitled to introduce competent evidence pertaining to the defense of lack of specific intent. While the competence and persuasiveness of the offered testimony can be questioned, the relevance of the subject matter cannot be."¹⁷⁵

167. Michael D. Greicius, Ben Krasnow, Allan L. Reiss & Vinod Menon, *Functional Connectivity in the Resting Brain: A Network Analysis of the Default Mode Hypothesis*, 100 PROCEEDINGS NAT'L ACAD. SCI. 253 (2003); Matthew J. Brookes, Mark Woolrich, Henry Luckhoo, Darren Price, Joanne R. Hale et al., *Investigating the Electrophysiological Basis of Resting State Networks Using Magnetoencephalography*, 108 PROCEEDINGS NAT'L ACAD. SCI. 16783, 16783 (2011).

168. See TYLER & BUTT, *supra* note 145.

169. *United States v. Hinckley*, 525 F. Supp. 1342 (D.D.C. 1981), *aff'd*, 672 F.2d 115 (D.C. Cir. 1982).

170. 370 So. 2d 1075 (Ala. Crim. App. 1975).

171. *Id.* at 1076–77.

172. *Id.*

173. 588 F.2d 721, 722 (9th Cir. 1978) (offering as specific proof in the case:

"The defendant offers to prove through Dr. John T. Saiddy that, based upon objective evidence of mental defect shown by a brain scan, as well as upon his own observations progressively made over a period of years concerning Morse Erskine as a patient, in addition to the observations of other persons brought to his attention, that Morse Erskine, in the realm of probability, did the matters referred to in the several indictments or omitted matters referred to in the indictments without knowing what he was doing and that similarly, in view of all the circumstances brought to the attention of Dr. John T. Saiddy, Morse Erskine, during the pertinent times in question, was not capable of forming the requisite criminal intent denounced by section 1014 of Title 18.")

174. *Id.* at 723.

175. *Id.*

In the 1979 case of *U.S. v. Frederick*, a defendant charged with murder argued that the lower court should have allowed him to get additional neuro-evaluations.¹⁷⁶ While his EEG showed normal results, experts testified that other scans were open to different interpretations. Ultimately, however, the court held the defendant suffered no prejudice by not having the additional testing done.¹⁷⁷

In *State v. Burnham*, in 1981, a defense expert concluded that EEG indicated abnormalities and a CT scan confirmed significant brain injury.¹⁷⁸ The defendant argued that the physician's report relating to the scans should have been admitted. The court held that because the report was relevant it should have been admitted. But since the report was cumulative, it was not prejudicial to exclude it, and amounted to "harmless error."¹⁷⁹

In *U.S. ex rel. S.E.C. v. Billingsley*, in 1985, the defendant argued the trial court improperly placed the burden of proof for fitness to stand trial on the defendant.¹⁸⁰ An expert testified, based in part on CAT and EEG data, that defendant had a "mild cognitive impairment."¹⁸¹ The court agreed and the case was remanded to determine the defendant's fitness for trial. Moreover, the appellate court held that placing the burden on the defendant was not harmless error.

In 1988, the defendant in *U.S. v. Bates* argued the trial court improperly denied him a full opportunity to present a psychiatric defense, specifically an EEG that employed a new mapping procedure.¹⁸² A standard EEG had shown no abnormalities and the defendant's claim was unsuccessful.¹⁸³ According to the court, the defendant had many opportunities to explore his mental health options and EEG, CAT, and X-rays had been performed—he was not entitled to anything further.¹⁸⁴

This very small sampling of cases demonstrates that a defendant's brain structure and function can be legally relevant, and that arguments based on brain structure and function findings are far from new. Further, the arguments that appear in the cases above are all arguments that continue to reappear in court today. While the technology has advanced considerably, and the arguments made involving neuroimaging evidence have become more detailed, courts have continued to respond in similar ways. Courts expect attorneys to collect or try to collect this type of data in certain circumstances, specifically in capital criminal trials involving defendants who have histories of head injuries and potential brain damage.¹⁸⁵ Trial counsel's responsibility is also reflected in the American Bar Association's (ABA) guidelines for defense counsel in death penalty cases. The ABA advises attorney's to pursue any testing necessary to thoroughly investigate a client's mental health and

176. 7 M.J. 791, 799–802 (N.C.M.R. 1979).

177. *Id.*

178. 427 A.2d 969, 972 (Me. 1981).

179. *Id.*

180. 766 F.2d 1015 (7th Cir. 1985).

181. *Id.* at 1026.

182. 865 F.2d 255, *2 (4th Cir. 1988).

183. *Id.*

184. *Id.* at *3–4.

185. *See Denno, supra* note 134, at 505–506.

neurological status, including “appropriate brain scans.”¹⁸⁶ As a result, attorneys who fail to adequately investigate a client’s potential neurological and mental health issues as possible mitigating evidence in capital cases may be found ineffective.¹⁸⁷

There are many different neuroimaging modalities with varying equipment, methods, and applications. Neuroimaging is a large field and the applications and data regarding each technique are diverse in both content, quality, and scope. Additionally, the corresponding peer-reviewed literature on each different modality (i.e. the framework evidence) and each different application of that modality in individual conditions (i.e. the diagnostic evidence) can vary from technique to technique. Clinical CT scans revealing a subdural hematoma, which are proffered to support a diagnosis of head trauma and traumatic brain injury are very different from a proffered expert claiming that a substance abuse disorder can be diagnosed from a PET scan. Accordingly, while both are examples of neuroimaging evidence, each should both be evaluated for reliability through the unique scientific understanding of the technique. Thus, the reliability of a given neuroimaging technique to investigate a specific question and support the subsequent expert testimony requires a detailed and nuanced analysis of the technique and opinion in question.¹⁸⁸

V. EVOLVING SCIENCE CAN BE RECOGNIZED BY THE LAW

In their rejection of *Frye* and adoption of a *Daubert* approach, the New Mexico Supreme Court indicated that courts should favor current scientific understanding over jurisprudential recognitions of scientific understandings.¹⁸⁹ The Court has also required the state’s trial courts to independently determine if reliability is sufficiently established.¹⁹⁰ Similarly, there are federal level appellate courts that have favored admitting testimony based on conflicting science if support is shown for the general scientific theory or technique being proffered.

This was the reasoning of the Ninth Circuit in *S.M. v. J.K.*, where a housekeeper brought a suit against her former employer for attempted sexual assault.¹⁹¹ The plaintiff’s expert had testified that the housekeeper-plaintiff suffered PTSD as a result of the sexual assault. The employer-defendant’s appeal challenged the expert’s testimony as not properly admitted and unreliable because it was not strictly based on the DSM-III-R.

186. AM. BAR ASS’N, GUIDELINES FOR THE APPOINTMENT AND PERFORMANCE OF DEFENSE COUNSEL IN DEATH PENALTY CASES 31 (Revised Ed. Feb. 2003), <http://www.americanbar.org/content/dam/aba/migrated/legalservices/downloads/sclaid/deathpenaltyguidelines2003.authcheckdam.pdf> (stating “[d]iagnostic studies, neuropsychological testing, appropriate brain scans, blood tests or genetic studies, and consultation with additional mental health specialists may also be necessary”)

187. *People v. Morgan*, 719 N.E.2d 681, 707–708 (Ill. 1999) (agreeing that trial counsel’s failure to investigate and present the mitigating evidence relating to the defendant’s organic brain damage was deficient and prejudicial as the inclusion of this evidence in the penalty phase could have likely resulted in the jury recommending a sentence other than death).

188. Lyn M. Gaudet, Julia R. Lushing, & Kent A. Kiehl, *Functional Magnetic Resonance Imaging in Court*, 5 AM. J. BIOETHICS NEUROSCIENCE 43, 45 (2014).

189. *State v. Alberico*, 1993-NMSC-047, ¶ 97, 861 P.2d 192.

190. *Id.* ¶ 53.

191. 262 F.3d 914 (9th Cir. 2001).

Specifically, the expert had testified that in diagnosing the plaintiff, he has relied on his own understanding of PTSD in addition to the DSM-III criteria.¹⁹² In order for a qualified expert to diagnose someone with PTSD, the DSM-III requires that a distressing event outside of the range of usual human experience occur.¹⁹³ The doctor had felt that the triggering event could be less severe than that.¹⁹⁴ Citing *Daubert*, the court held that it may “admit somewhat questionable testimony if it falls within the range where experts might reasonably differ, and where the jury must decide among the conflicting views.”¹⁹⁵ Consequently, the variance between the expert’s opinion and the DSM should have been explored in cross-examination instead of being used as a means of throwing out the doctor’s opinion altogether.¹⁹⁶ Unique to this case is the fact that between the time of the trial and the appeal, the American Psychiatric Association released the DSM-IV, which did coalesce with the expert’s opinion in *S.M.* because it omitted the requirement that the triggering event be outside the range of normal human experience. The Ninth Circuit Court of Appeals acknowledged the DSM’s changed definition:

Most importantly, the fourth edition of the DSM (“DSM-IV”) has omitted the requirement that the triggering event be outside the range of normal human experience. Reflecting the general trend in his field, Dr. McKenna’s diagnostic criteria apparently now enjoy general acceptance. Therefore, the magistrate judge did not abuse his discretion in admitting Dr. McKenna’s testimony.¹⁹⁷

Only after providing a meaningful review of the general and individual dichotomy underlying an expert opinion, should a court then allow a disagreement among opposing experts to be decided by the fact finder.

And *Daubert* does not need to be modified for courts to make the important threshold determination, distinguishing between unsupported scientific claims—whether because they have no support or because the research that does exist does not support the conclusion being made—and those where the scientific method has been applied but there is reasonable disagreement as to the strength or interpretation of the findings.¹⁹⁸

In commenting on the marked increase in neuroscience and neuroimaging evidence in criminal cases in recent years Professor Francis Shen notes that once a technology or technique “becomes clinically relevant, it will become legally relevant.”¹⁹⁹ While it is correct that clinically relevant techniques are legally relevant, a technique or tool can become legally relevant even before it reaches that threshold.

192. *Id.* at 921.

193. *Id.*

194. *Id.*

195. *Id.* (quoting *Kumho Tire Co. v. Carmichael*, 526 U.S. 137, 153 (1999)).

196. *S.M.*, 262 F.3d at 921 (quoting *Daubert v. Merrell Dow Pharm.*, 509 U.S. 579, 596 (1993)).

197. *S.M.*, 262 F.3d at 922.

198. Steve C. Gold, *A Fitting Vision of Science for the Courtroom*, 3 WAKE FOREST J.L. & POL’Y 1, 20 (2013).

199. Greg Miller, *The Brain Gets Its Day in Court*, THE ATLANTIC, Mar. 1, 2016, <http://www.theatlantic.com/science/archive/2016/03/neurolaw-brain-scans-court/471615/>.

Determining if a technique or theory is clinically relevant is a high and hard bar to meet. One possible way to gauge clinical significance is by the medical standard of care.²⁰⁰ Yet the standard of care in a legal construct based on what constitutes medical malpractice, and that construct is always evolving.²⁰¹

Eventually a test, method, or procedure is adopted by a certain percentage of the medical community such that it becomes the standard. But up until the actual shift—when the test, method, or procedure crosses that amorphous, highly-context specific line that divides unexpected and expected care—it does not mean that medical providers that had already been using said test, method, or procedure were *not* appropriately practicing medicine. Those early medical adopters were simply ahead of the curve, providing better than minimally competent care. The standard doesn't usually penalize physicians for being ahead, it penalizes them for being behind.²⁰² Under our legal framework and admissibility standards a new technique applied to a specific case is not inherently unreliable. There will always be early adopters of new technologies and approaches, and those that push the envelope with regards to the type of evidence they seek to admit. *Daubert* permits courts to evaluate all evidence—no matter how old, established, novel, or unique.

Put another way, it is fair to say that once something is clinically relevant and generally accepted by the majority of those that practice medicine, it will not be a difficult question for the courts. The value in the *Daubert* test is its ability to provide a way for courts to determine whether something is admissible *before* everyone, everywhere has determined the technology or approach is reliable.

VI. APPLYING DAUBERT/ALBERICO TO FRAMEWORK AND DIAGNOSTIC NEUROSCIENCE EVIDENCE

Daubert and *Alberico* provide important factors to consider when assessing the admissibility of novel science. The first step is identifying the framework technique or theory subject to a reliability assessment. As with all science, when it comes to novel science, it is also important not to grant a blanket acceptance of a technique or method just because it has been found reliable in general. Establishing the reliability of the individual application of that general scientific methodology is equally as necessary and should not be overlooked.

If prior to admitting DNA evidence, trial courts had required a benchmark showing of reliability through evidence of procedural controls, testing practices, and error rates of individual labs and technicians, it is reasonable to believe that much of

200. See generally *Hall v. Hilburn*, 466 So. 2d 856 (Miss. 1985).

201. Peter Moffett & Gregory Moore, *The Standard of Care: Legal History and Definitions: The Bad and Good News*, 12 WESTERN J. EMERGENCY MEDICINE 109, 112 (2011).

202. *Id.* (quoting the jury instructions provided by the trial judge in the medical malpractice case, *McCourt v. Abernathy*, 457 S.E.2d 603 (S.C. 1995) “The mere fact that the plaintiff’s expert may use a different approach is not considered a deviation from the recognized standard of medical care. Nor is the standard violated because the expert disagrees with a defendant as to what is the best or better approach in treating a patient. Medicine is an inexact science, and generally qualified physicians may differ as to what constitutes a preferable course of treatment. Such differences due to preference . . . do not amount to malpractice. I further charge you that the degree of skill and care that a physician must use in diagnosing a condition is that which would be exercised by competent practitioners in the defendant doctors’ field of medicine”)

the faulty DNA evidence would not have been admitted into courtrooms across the country. By not requiring any measures of the reliability for individual test results, there were no safeguards against the very abuses that rendered the data unreliable.²⁰³ By saying that the individual application reliability analysis is a matter of weight instead of admissibility, data from faulty crime labs were cloaked in an undeserved veil of credibility for many years.

Applying the G2i framework makes it easier to tease apart the underlying general methodology, technique, and data from the individual application of that technique leading to the expert opinion in question. Evaluating both the general and individual aspects behind a neuroimaging finding allows the court to correctly weigh when there is enough data and supporting literature for the imaging results themselves to be admitted for the purpose being proffered. Appropriately-qualified experts can still professionally disagree as to the significance of the findings. And that disagreement should go to weight, not admissibility, once the benchmark of reliability has been met.

An example of when a court has deemed the reliability of a technique enough so that subsequent disagreements among experts can be decided in terms of weight by the fact finder is the Federal District of New Mexico case, *Booth v. Kit, Inc.*²⁰⁴ The evidence at issue was a specific type of structural MRI data called diffusion tensor imaging (DTI) data.²⁰⁵ The court found that the DTI technique generally and as applied in this case had been sufficiently tested, it was subject to peer-review, it lacked a high error rate, and was generally accepted in the scientific community for measuring the integrity of the white matter of the brain.²⁰⁶ As a result, the DTI data and expert opinion testimony was admitted. The court explained “any perceived weaknesses [of the expert’s testimony] may be attacked on cross-examination or by contradictory opinions by one or more qualified experts.”²⁰⁷ The court’s evaluation of DTI imaging and its conclusion that the technique was sufficiently reliable was appropriate in that it ensured the data in the individual case was collected and analyzed in a reliable way and was applied appropriately to a question that the DTI technique has been validated on.

For future applications of the *Daubert/Alberico* factors to neuroimaging evidence, a similar analysis of both the framework neuroimaging evidence and the individual application of the imaging conducted should be carried out. Under the testability factor, diagnostic neuroscience evidence should be evaluated for the presence of a proof verification method. In regard to MRI evidence, does the radiologist or neuroradiologist test his or her diagnosis through the presence of feedback loops, where independent verification of a finding is tested? Or, is the individual information collected so that a diagnosis may one day be confirmed or denied, even if concurrent validation is unavailable?

Likewise, the court should evaluate what the diagnostic error rate of a neuroscientific technique is or if one exists. Questions should be asked, such as, does

203. See, e.g., Tovia Smith, *Crime Lab Scandal Leaves Mass. Legal System in Turmoil*, NPR (Mar. 4, 2013), <http://www.npr.org/2013/03/14/174269211/mass-crime-lab-scandal-reverberates-across-state>.

204. Civ. No. 06-1219 JP/KBM, 2009 WL 4544743 (D.N.M. Mar. 23, 2009).

205. *Id.*

206. *Id.*

207. *Id.* at *4.

the analysis leading to the diagnosis have a known false positive rate, and if so, what is it? The inverse should also be asked, as in, does the technique ever point to incorrect findings during clinical use?

Peer review and publication of diagnostic neuroscience evidence is perhaps the easiest factor to investigate. A simple Google Scholar search of neuroimaging and diagnosis provides more than a quarter of a million citations.²⁰⁸ Neuroscience and neuroimaging research continues to receive broad grant support and funding.²⁰⁹ And since each neuroscientific technique is subject to peer-reviewed and published articles, tracking the review and approval of the diagnostic use and techniques employed in each is widely available.

As with the publication factor, general acceptance of the diagnostic use of neuroscience and neuroimaging evidence can often be easily evaluated. While still novel science for some applications, much of neuroscience has reached established science. Furthermore, the cutting edges of neuroimaging data, which remain novel science, are not practiced on the fringes of the scientific community, but, rather, are often being researched by many institutions and universities across the country.

Like the DNA examples earlier, evaluation of neuroimaging evidence is best done through the dual G2i approach. By reviewing both the general scientific theory or technique and the individual application of that scientific theory or technique the likelihood of admitting good science that was poorly applied is reduced. This method also permits subject matter experts to reasonably disagree if competing data or interpretation contradicts the otherwise reliable, though novel theory or technique.

CONCLUSION

Just because comparisons between known and unknown DNA samples can be made reliably in accordance with accepted methods and protocols does *not* mean that an individual lab and its staff followed said methods and protocols with the testing of a particular sample or samples.²¹⁰ Determining the reliability of the latter requires assessing the individual details and specific data in each case. Using the G2i framework in the context of a *Daubert* analysis allows for that dual reliability assessment to occur. This technique is equally valuable when evaluating established disciplines like DNA testing as well as rapidly advancing areas of science, such as neuroimaging.

208. Google Scholar, neuroscience & diagnosis, <http://scholar.google.com/> (last visited May 16, 2016).

209. See eg, Details Emerge on Obama Brain Initiative Grants for the Neuroimaging Community, AMERICAN SOCIETY OF NEURORADIOLOGY (2014), <http://www.asnr.org/blog/details-emerge-obama-brain-initiative-grants-neuroimaging-community> (last visited May 16, 2016) (stating “a total of \$4 million – 10% of the total NIH BRAIN funding pool – has been allocated for advanced human brain imaging projects.”)

210. See, e.g., Seattle Post-Intelligencer Staff, *DNA Testing Mistakes at the State Patrol Crime Labs*, SEATTLE POST-INTELLIGENCER, July 21, 2004, <http://www.seattlepi.com/local/article/DNA-testing-mistakes-at-the-State-Patrol-crime-1149846.php>; Brendan J. Lyons, *Scientists Suspended as State Police DNA Scandal Deepens*, TIMESUNION, Apr. 12, 2015, <http://www.timesunion.com/news/article/Scientists-suspended-as-State-Police-DNA-scandal-6194258.php>.

In their application of *Daubert* the courts are instructed to use sound science as their guide in admissibility decisions. And in order to ensure that only reasonably reliable expert opinions enter the courtroom, the courts must assess whether the individual application of an otherwise reliable general theory was also applied in a reasonably reliable way in the case at hand. Courts certainly should not deem a novel scientific finding as unreliable simply because it is not a settled scientific theory. With matters based on settled science, *Daubert's* weighing and assessment of the underlying support would be unnecessary. Only with the evaluation of novel scientific ideas can *Daubert* truly be put into practice. And *Daubert* should not scare away the introduction of novel scientific ideas. The questioning of the status quo, the search for innovative methods, and application of new ways of thinking about old problems is how most fields, including science, progress. The law should be no different.