Neuroimaging Evidence: A Solution to the Problem of Proving Pain and Suffering?

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CONTENTS

INTRODUCTION

Envision a plaintiff who was injured on the job at a construction site due to his employer's negligence. The plaintiff has chronic back pain, but it is not verifiable on an X-ray, nor is a physical injury readily discernible by any other technology. Presently, fact finders are given the broad discretion to decide whether they find this plaintiff credible, and accordingly, whether they believe he is truly in pain and deserves dam-

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ages for pain and suffering. However, neuroimaging—specifically functional magnetic resonance imaging (fMRI)[1]—could allow those fact finders to visualize whether this plaintiff was hurting by depicting the unique signatures that are activated in the brain when the plaintiff experiences pain. Accordingly, the use of fMRI imaging would potentially provide a more objective basis through which fact finders could decide whether this plaintiff was legitimately suffering from chronic pain.

The price paid for pain and suffering in litigation is extraordinarily high. Damage awards for injuries stemming from pain and suffering in tort amount to billions of dollars per year.[2] Disability benefits alone, which are often awarded to those who suffer—or claim to suffer—chronic pain, constitute over $100 billion annually.[3]

Nonpecuniary damages have historically been difficult to calculate. In contrast to pecuniary damages, pain and suffering, emotional harms, and damages stemming from "invisible injuries" often have no ceiling or floor, and jury awards can range from massive sums to no award at all, presumably based on the jury's partiality and trust toward a particular plaintiff.[4] Because of the difficulty in affixing a monetary value to these nonmonetary injuries, legislators and legal theorists over the years have attempted to develop a more concrete method of calculating these damages.

State legislatures have experimented with statutes that limit nonpecuniary damage awards for particular causes of action with varying success. Some states have statutes in place that cap nonpecuniary damages at a predefined value,[5] while other states' statutes use a combination of a hard cap and formulas that take variables into account such as life

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1. *See infra* Part I.B for a description of functional magnetic resonance imaging (fMRI) and other neuroimaging technologies.

2. Amanda Pustilnik, *Exploring the Brain in Pain: An Applied Neuroscience & Law Initiative*, MASS. GEN. HOSP. CTR. FOR L. BRAIN & BEHAV. (Oct. 6, 2014), http://clbb.mgh.harvard.edu/pustilnik-blog-1.

3. *Id.*

4. *See, e.g.*, Paul DeCamp, *Beyond* State Farm*: Due Process Constraints on Noneconomic Compensatory Damages*, 27 HARV. J.L. & PUB. POL'Y 231, 258–59 (2003) (arguing in part that fact finders are given little guidance in assessing noneconomic compensatory damages and that "[t]he fundamental problem at [the damage assessment] point in the process is that the jury has essentially been asked to conjure a damages figure from thin air").

5. *See, e.g.*, WIS. STAT. §§ 893.55, 895.04 (2014) (limiting award of noneconomic damages in medical liability cases to $750,000, indexed for inflation); *see also* COLO. REV. STAT. § 13-64-302 (2015) (limiting award of noneconomic damages in medical liability cases to $250,000, and limiting total award of damages to $1,000,000); KAN. STAT. ANN. §§ 60-19a02, 60-1903 (West, Westlaw through 2015 Regular Sess.) (limiting noneconomic damages to $250,000 for causes of action accruing between July 1, 1988 and July 1, 2014; $300,000 for causes of action accruing between July 1, 2014 and July 1, 2018; $325,000 for causes of action accruing between July 1, 2018 and July 1, 2022; and $350,000 for causes of action accruing on or after July 1, 2022).

expectancy and earnings.[6] State courts have differed in their views as to the constitutionality of damage-capping statutes. These statutes have been challenged and upheld by some state courts,[7] while others have struck them down on constitutional grounds.[8] Presently, there are as many damage award structures as there are states, and it is clear that the noneconomic damages system is in flux nationally. Unsurprisingly, legal scholars have suggested a range of alternative damage award structures on which states could base their statutory schemes.

Some legal scholars have proposed replacing the current pain and suffering award system—a system that relies on broad jury discretion and damage caps—with a "system of quantitative 'scheduling' of awards for nonpecuniary loss."[9] Three alternative scheduling models have been suggested.[10] The first alternative is "a system of standardized awards set according to a matrix of dollar values based on victim age and injury severity."[11] The second is "a scenario-based system that employs descriptions of prototypical injuries with corresponding award values designed to be given to juries as guides to valuation."[12] The final alternative is "a system of flexible ranges of award floors and caps that reflect the various categories of injury severity."[13] Because these schedules can more comprehensively address the variability and predictability of problems in damage awards, the proponents of these alternatives propose that a sys-

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6. *See, e.g.*, ALASKA STAT. § 09.17.010 (2014) (limiting noneconomic damages for personal injury or wrongful death actions to "$400,000 or the injured person's life expectancy in years multiplied by $8,000, whichever is greater[,]" subject to certain exceptions).

7. *See, e.g.*, Miller v. Johnson, 289 P.3d 1098, 1121 (Kan. 2012) (upholding Kansas statute capping noneconomic damages under a rational basis review, finding it "'reasonably conceivable' under the rational basis standard that imposing a limit on noneconomic damages furthers the objective of reducing and stabilizing insurance premiums by providing predictability and eliminating the possibility of large noneconomic damages awards").

8. *See, e.g.*, Moore v. Mobile Infirmary Ass'n, 592 So. 2d 156, 170 (Ala. 1991) (invalidating statute requiring $400,000 noneconomic damages cap on grounds that the statute "violates the principle of equal protection as guaranteed by §§ 1, 6, and 22 of the Constitution of Alabama"); State *ex rel.* Ohio Acad. of Trial Lawyers v. Sheward, 715 N.E.2d 1062, 1095 (Ohio 1999) (holding statute that capped noneconomic damage awards in personal injury cases to $200,000 "invalid on due process grounds because it is unreasonable and arbitrary, irrespective of whether it bears a real and substantial relation to public health or welfare"); Sofie v. Fibreboard Corp., 771 P.2d 711, 728, *amended by* 780 P.2d 260 (Wash. 1989) (invalidating Washington state statute that limited the award of noneconomic damages for bodily injury to 43% of the average annual wage multiplied by the plaintiff's life expectancy on the grounds that the variable limit on noneconomic damages awards violated the right to a trial by jury provided for by the Washington State Constitution).

9. Randall R. Bovbjerg, Frank A. Sloan & James F. Blumstein, *Valuing Life and Limb in Tort: Scheduling "Pain and Suffering,"* 83 NW. U. L. REV. 908, 975 (1989).

10. *Id.*

11. *Id.*

12. *Id.*

13. *Id.*

tem of matrices or scenarios is superior to the floors and caps system.[14] Again, a floors and caps system enables broad jury discretion, which might be avoided through matrices or scenarios.

Unfortunately, despite the fact that these alternatives are generally well-accepted in the legal community, the system for awarding pain and suffering damages has remained in a stagnant state—a system that relies on the broad discretion of the jury. Thus, with nonpecuniary damages award systems in a state of flux, it is reasonable to begin searching for alternative models which might provide a more objective system of measuring noneconomic injuries.

This Note discusses the pros, cons, and feasibility of a pain and suffering award system that incorporates neuroimaging evidence, where a floors and caps system would be largely unnecessary and plaintiffs would be able to collect the awards they deserve while still operating within a system based on narrowed jury discretion. This Note argues that, while holding promise for the near future, the current pain neuroimaging technology is not sufficiently reliable nor accepted in the scientific community to warrant widespread use in litigation to prove pain and suffering injuries, and at present, courts are likely to exclude pain scans because of their prejudicial nature.

First, Part I provides a brief background of current structural and functional neuroimaging technology and whether the technology can be used to prove pain and suffering. Next, Part II discusses the evidentiary hurdles for getting neuroimages admitted as evidence as seen in a wide variety of cases where courts have admitted or denied neuroimaging evidence. Part III analyzes the potential uses of neuroimaging evidence in proving pain and suffering and the implicit problems with its admission into the courtroom. Finally, this Note ultimately concludes that because the technology is not presently generally accepted in the scientific community as a verifiable method to prove pain, the judicial system is not currently prepared for the broad-scale admission of neuroimaging evidence to prove pain and suffering.

I. BACKGROUND: AVAILABLE NEUROIMAGING TECHNOLOGY

Neuroimages are generated by computers, are produced from noninvasive techniques, and represent both the brain's structure and function.[15] The technology is relatively new.[16] In order to understand why

14. *Id.*

15. *See* Elizabeth Haberfeld et al., *Neuroimaging: Visualizing Brain Structure and Function*, CTR. FOR BIOETHICS AT COLUMBIA UNIV., http://ccnmtl.columbia.edu/projects/neuroethics/module1/foundationtext/index.html (last visited Mar. 27, 2016).

16. *See id.*

neuroimages should not be admitted as evidence to prove pain and suffering at this stage, it is imperative to have a basic understanding of the technology itself. This Part first provides background information on structural and functional neuroimaging techniques. It then discusses the structural regions of the brain believed to be implicated in pain perception and explains how the current technology may be used to prove pain and suffering.

A. Structural Neuroimaging Technology

Two techniques are primarily used to generate structural neuroimages (images of the brain's structure): computerized tomography (CT) and magnetic resonance imaging (MRI).[17] MRIs are expensive and produce a high-quality image, while CT scans are less expensive but of lower quality.[18] Additionally, MRIs take longer to capture and produce an image.[19]

CT scans "measure the attenuation of X-ray beams passing through target tissue," or in other words, the scans produce black and white images that show the degree that different types of brain tissue absorb and deflect X-ray beams, which provides a structural image.[20] A subtype of CT that is useful for showing how blood flows to particular regions of the brain is the single positron emission CT (SPECT).[21] A SPECT scan integrates CT and also incorporates a radioactive tracer to view the brain and body; the tracer allows clinicians to see how blood flows to tissues and organs.[22] CT scans are widely used in medicine and produce an accurate image of a particular patient's brain structure.[23]

In MRI, "grayscale images are constructed from the electromagnetic signals that are emitted by the proton nuclei of hydrogen atoms, which are found predominantly in tissue water."[24] In order to obtain MRI images, a person is placed in an MRI scanner, which has a strong external magnetic field, and the nuclei in the patient's brain tissue are pulsed with radio frequency waves, producing a structural image.[25] Like CT scans,

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17. *Id.*

18. *Id.*

19. *Id.*

20. Jeffery A. Coffman, *Computed Tomography in Psychiatry*, *in* BRAIN IMAGING: APPLICATIONS IN PSYCHIATRY 1, 5 (Nancy C. Andreasen ed., 1989).

21. *SPECT (Single Photon Emission Computed Tomography) Scan*, MAYFIELD BRAIN & SPINE, http://www.mayfieldclinic.com/PE-SPECT.htm (last visited Mar. 27, 2016).

22. *Id.*

23. Coffman, *supra* note 20, at 1.

24. Jennifer Kulynych, Note, *Psychiatric Neuroimaging Evidence: A High-Tech Crystal Ball?*, 49 STAN. L. REV. 1249, 1255 (1997).

25. *Id.*

MRI is a reliable and common method of producing structural images of the brain.[26]

Though MRI is the more expensive of the structural neuroimaging techniques, it does offer advantages over CT.[27] The first advantage is that, unlike CT, in which multiple images should not be taken sequentially due to the risk of radiation exposure, MRI allows multiple scans to gather images in rapid sequence with no risk of radiation overexposure.[28] The second advantage is that MRI has vastly superior anatomical resolution for soft tissue structures, which is highly desirable in all settings.[29] Both of these technologies have traditionally been used to show and prove physical injuries to the brain.

B. Functional Neuroimaging Technology

In contrast to the structural neuroimaging techniques described in the previous subsection, functional neuroimages actually capture images of the brain while in action.[30] The two most prevalent functional neuroimaging techniques are positron emission tomography (PET) and functional magnetic resonance imaging (fMRI).[31]

PET scans detect the spatial distribution of water molecules or glucose molecules within the brain, which are labeled with positron-emitting radioisotopes.[32] The radioisotope data from the PET scanner is then computer-analyzed in order to determine the relative differences in metabolic rates across the structures of the brain.[33] The resulting computer-generated image depicts metabolic rates through color gradations.[34] From these images, scientists can infer that the brain structures that have the highest metabolic rates are those that are most involved and active in responding to different stimuli—for example, pain.[35]

Conversely, fMRIs measure blood oxygenation levels within the brain in order to determine which brain structures are being utilized

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26. *Id.*

27. Nancy C. Andreasen, *Introduction* to BRAIN IMAGING: APPLICATIONS IN PSYCHIATRY, *supra* note 20, at ix, x.

28. Nancy C. Andreasen, *Nuclear Magnetic Resonance Imaging*, *in* BRAIN IMAGING: APPLICATIONS IN PSYCHIATRY, *supra* note 20, at 67, 68.

29. *Id.* at 68.

30. Henry H. Holcomb et al., *Positron Emission Tomography: Measuring the Metabolic and Neurochemical Characteristics of the Living Human Nervous System*, *in* BRAIN IMAGING: APPLICATIONS IN PSYCHIATRY, *supra* note 20, at 235, 236–37.

31. *See generally* Andreasen, *supra* note 27.

32. Holcomb, *supra* note 30, at 238.

33. *Id.* at 236–37.

34. *See id.* at 240–41.

35. *See id.* at 237.

when a subject performs a cognitive activity.[36] This technique measures the change in the blood oxygenation level using a method called blood-oxygenation-level dependent contrast imaging, which is an index of metabolic activity and superimposes data onto a static, structural MRI image of the brain.[37] This process produces neuroimages with high resolution and dynamic information about brain activity.[38]

Similarly to a PET scan, fMRI allows scientists to make inferences based on the relationship between changes in brain structures and the subject's mental activity.[39] Both of these technologies have widespread clinical application. For example, researchers have used PET and fMRI to pinpoint regions of the brain associated with the human perception of pain,[40] which is essential if these technologies are to be admitted as evidence of a litigant's pain and suffering, or lack thereof.

C. Locating Structural Regions of the Brain Implicated in Pain Perception with Presently Available Technology

These new neuroimaging techniques have allowed researchers to discover structures of the brain that are responsible for pain perception with rapidly increasing accuracy and understanding.[41] The idea of pain signals being conducted by a distinct class of neurons, or brain cells, was first described in 1906.[42] Since then, PET and fMRI have allowed researchers to hone in on specific areas of the brain that they believe are responsible for the human experience of pain.[43] Early studies of the brain regions responsible for the pain experience were performed using PET and quickly furthered our understanding of the brain's role in the pain sensation.[44]

PET studies have shown that large distributed brain networks were activated during painful stimulation.[45] Research indicates that the cortical and subcortical regions—the brain regions consisting of the cortex and regions below the cortex—that activate during pain stimulation include the anterior cingulate cortex, insula, frontal cortices, primary somatosen-

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36. Kulynych, *supra* note 24, at 1256.

37. *Id.*

38. *Id.*

39. *Id.*

40. Jonathan Brooks & Irene Tracey, *From Nociception to Pain Perception: Imaging the Spinal and Supraspinal Pathways*, 207 J. ANATOMY 19, 19 (2005).

41. *See id.*

42. *See generally* CHARLES S. SHERRINGTON, THE INTEGRATIVE ACTION OF THE NERVOUS SYSTEM (Oxford Univ. Press 1906).

43. *See* Brooks & Tracey, *supra* note 40, at 20.

44. *Id.*

45. *Id.* at 22.

sory cortex, second somatosensory cortex, and amygdala.[46] This amalgam of brain structures has since been dubbed the "pain matrix."[47]

The pain matrix is divided into medial and lateral pain systems.[48] Although this is a simplified distinction of the involved neural networks, it is a useful categorization because brain regions that appear to have similar roles in pain perception are grouped together.[49] The lateral pain system, which consists of the primary and secondary somatosensory cortex (regions that are responsible for handling most sensory perceptions), is thought to be primarily responsible for discerning the location and intensity of painful stimuli.[50] Conversely, the anterior cingulate cortex is believed to be involved in the cognitive-evaluative component—the experiential and analytical aspect of pain.[51] Additionally, the insula is believed to encode both the intensity and the laterality (whether pain is on the left or right side of the body) of both painful and nonpainful thermal stimuli, as well as potentially having a role in affective pain processing, which is the emotional response to pain.[52] Accordingly, it is likely that the insula is responsible for integrating information from both the medial and lateral systems.[53] Through pinpointing specific brain regions responsible for different aspects of the experience of pain, this data will allow for litigants to prove what they are experiencing with more precision.

Using electroencephalography, which is not a neuroimaging technique but rather a method of measuring electrical activity in the brain, our current understanding of the pain matrix and its processing of pain has further improved.[54] It is now believed that the frontal operculum, which includes the secondary somatosensory cortex and insula, are very strongly implicated in pain sensation.[55] For example, these regions of the brain are the only cortical regions found to produce a perception of pain in response to direct electrical stimulation.[56] The above group of brain structures is not an exhaustive list of structures involved in pain perception, but illustrates that at this point, researchers have been able to locate specific regions of the brain that allow humans to experience pain.

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46. *Id.*
47. *Id.*
48. *Id.*
49. *Id.*
50. M. C. Bushnell et al., *Pain Perception: Is There a Role for Primary Somatosensory Cortex?*, 96 PROC. NAT'L ACAD. SCI. 7705, 7705 (1999).
51. Pierre Rainville et al., *Pain Affect Encoded in Human Anterior Cingulate but Not Somatosensory Cortex*, 277 SCIENCE 968, 968 (1997).
52. Brooks & Tracey, *supra* note 40, at 23.
53. *Id.*
54. *Id.*
55. *Id.*
56. *Id.*

Although it is clear that the current technology has allowed researchers to discover structures of the brain that are responsible for pain perception, whether this is enough to prove pain and suffering in court is more tenuous.

D. Using Neuroimaging Technology to Prove Pain and Suffering

Experts' opinions on whether neuroimaging technology is reliable and accurate enough for courtroom use are conflicting, but the reliability of the technology has increased markedly in a very short period of time.[57] For example, a neurologist and director of Stanford University's Pain Management Center testified as an expert in a workers' compensation case wherein an employee suffered chemical burns that he alleged left him with chronic pain. The neurologist stated that he was "of the strong opinion that in 2008, we cannot use fMRI to detect pain, and we should not be using it in a legal setting."[58] Although the employee's lawyers assembled evidence that included an fMRI scan showing increased activity in the pain matrix of the brain, this neurologist, in testifying for the defense, did not feel the technology and its use in assessing and showing pain were reliable enough at that time.[59]

More recently, however, a greater body of research has developed using fMRI to show pain.[60] In 2013, for example, in four studies involving 114 participants, researchers developed an fMRI-based measure that predicts pain intensity individualized to the particular participant (a "neurologic signature").[61] The results of their studies showed significant promise for the use of fMRI in measuring pain.[62] In two of the studies, researchers found that the neurologic signature correlated pain sensitivity and brain structures with the subjects' ability to discriminate painful heat from a simple sensation of warmth, and the subjects' ability to anticipate pain and recall pain.[63] In the third study, the neurologic signature discriminated between physical pain and social pain, and in the last study, the strength of the neurologic signature was "substantially reduced" when an analgesic was administered.[64] These results strongly indicate

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57. *See generally id.*

58. Greg Miller, *Brain Scans of Pain Raise Questions for the Law*, 323 SCIENCE 195, 195 (2009), *available at* http://apkarianlab.northwestern.edu/media/ScncePainConf.pdf (quoting neurologist Sean Mackey).

59. *Id.*

60. Tor D. Wager et al., *An fMRI-Based Neurologic Signature of Physical Pain*, 368 NEW ENG. J. MED. 1388, 1388 (2013), *available at* http://www.nejm.org/doi/pdf/10.1056/NEJMoa1204471.

61. *Id.*

62. *See id.*

63. *Id.*

64. *Id.*

that it is possible to use fMRI to assess pain in healthy persons.[65] The problem is that many external factors affect an individual's pain perception, and less is known about the individual's neurologic signature in response to chronic pain, which is often the injury claimed for pain and suffering damages.

Preliminarily, sensitivity to pain varies significantly from one individual to another.[66] Additionally, psychological factors including anxiety, attention, and distractions likely alter neurologic signatures in fMRI scans.[67] Anxiety and focusing on pain often increase pain; consequently, they will strengthen the pain's neurologic signature in fMRI scans.[68] In contrast, distraction from pain will often decrease the neurologic signature.[69] Further, imagined pain often activates the same regions of the pain matrix as real pain.[70] This creates substantial problems when claiming damages because plaintiffs with frivolous lawsuits who exaggerate their pain could potentially exploit fMRI evidence to further their claims.

In contrast, based on current studies, other neuroscientists believe that the time for fMRI pain evidence is nigh. One study found that activity in the medial prefrontal cortex and right insula correlated strongly with the duration and intensity of chronic pain in individuals with chronic back pain.[71] This sect of neuroscientists is optimistic that the fMRI technique provides an "objective measure of pain in these patients."[72] Legal commentators following the development of the science believe the legal sector may utilize the science even before the scientific community at large is satisfied with the technique. One law professor noted that fMRI-pain researchers "care more about causation than we do in the law," and that "[i]f the correlation is high enough . . . we [in the law] would see that as a useful tool."[73] Thus, even if researchers do not find the near perfect correlation between pain stimuli and neurologic signature they strive for in their research, the technology might still enter the courtroom because of trial judges' discretion in the admission of scientific and expert evidence.

Because there are two schools of thought regarding the reliability of fMRI and neuroimaging technology in accurately showing real pain, whether neuroimaging evidence will be admitted will likely come down

65. *See id.*
66. Miller, *supra* note 58, at 195.
67. *Id.*
68. *Id.*
69. *Id.*
70. *Id.*
71. *Id.*
72. *Id.*
73. *Id.*

to the credibility of the expert testifying on either side. Accordingly, attempting to have neuroimaging pain evidence admitted in litigation is not an easy task at this point due to evidentiary standards.

II. EVIDENTIARY HURDLES IN ADMITTING NEUROIMAGING EVIDENCE

Although neuroimaging techniques have allowed us to somewhat reliably visualize the sensation of pain, lawyers have encountered difficulty in getting neuroimages and expert testimony regarding neuroimages admitted into evidence. This Part provides an overview of the *Frye* and *Daubert* standards for the admission of scientific evidence and examines whether neuroimages might be admitted under these standards by analyzing cases where it has been attempted. Finally, this Part concludes by explaining why *Daubert* jurisdictions are likely to be more amenable to the admission of neuroimaging evidence.

The majority rule for admissibility of scientific evidence prior to the adoption of the Federal Rules of Evidence (FRE) was the "general acceptance" standard.[74] This standard, known as the "*Frye* standard," requires any scientific evidence to be generally accepted in the scientific community in order to be admitted into evidence.[75] In *Frye*, the court faced the decision of whether to admit the systolic blood pressure deception test; this test is based on the theory that truth is spontaneous and comes without conscious effort, while the utterance of a falsehood requires a conscious effort that is resultantly reflected in an individual's blood pressure.[76] The court held that this test did not have the requisite recognition and general acceptance among psychological and physiological authorities necessary to justify admitting expert testimony on the defendant's behalf.[77] Although the *Frye* standard is still used in some states, the United States Supreme Court determined in *Daubert v. Merrell Dow Pharmaceuticals, Inc.* that FRE 702 superseded *Frye* for claims arising in federal courts.[78]

The Court in *Daubert* looked to *United States v. Abel* in determining whether common law evidence standards could still be relevant in the new world of the Federal Rules of Evidence.[79] Taking particular note of

74. *See* Frye v. United States, 293 F. 1013 (D.C. Cir. 1923).

75. *Id.* at 1014.

76. *Id.*

77. *Id.*

78. *See* Daubert v. Merrell Dow Pharm., Inc., 509 U.S. 579, 587 (1993).

79. *Id.* at 588–89; *see* United States v. Abel, 469 U.S. 45, 51–52 (1984) ("In principle, under the Federal Rules no common law of evidence remains. 'All relevant evidence is admissible, except as otherwise provided . . . .' In reality, of course, the body of common law knowledge continues to exist, though in the somewhat altered form of a source of guidance in the exercise of delegated pow-

FRE 402, which states in pertinent part, "[a]ll relevant evidence is admissible, except as otherwise provided by the Constitution of the United States, by Act of Congress, by these rules, or by other rules prescribed by the Supreme Court pursuant to statutory authority," the Court was faced with a difficult decision due to the potential relevancy of scientific evidence inherent in many criminal and civil trials.[80] The Court held that FRE 702 speaks to the common law standard set forth in *Frye*.[81]

FRE 702, which governs the admissibility of expert testimony, provides: If "scientific, technical, or other specialized knowledge will help the trier of fact to understand the evidence or to determine a fact in issue," then "[a] witness who is qualified as an expert by knowledge, skill, experience, training, or education, may testify [thereto] in the form of an opinion or otherwise."[82] Per *Daubert*, because FRE 702's text does not establish general acceptance as an absolute prerequisite to admissibility, nor does anything in the Federal Rules of Evidence indicate that the Rules as a whole were intended to incorporate a general acceptance standard, the general acceptance standard should not be applied in federal trials.[83]

As a result, the Court held that general acceptance is not a precondition to the admissibility of scientific evidence.[84] The Court further held that "the Rules of Evidence—especially Rule 702—[assigned] to the trial judge the task of ensuring that an expert's testimony both rests on a reliable foundation and is relevant to the task at hand," and that "[p]ertinent evidence based on scientifically valid principles will satisfy those demands."[85] Additionally, the Court added several nonexclusive factors to determine the reliability of the expert testimony, including whether the technique has been tested, whether the technique has been subjected to peer review and publication, the potential error rate in using the technique, the existence and maintenance of standards controlling the technique's operation, and whether the technique has been generally accepted in the scientific community.[86] Thus, the Court concluded that the Federal Rules of Evidence superseded *Frye*.[87] The *Daubert* factor test has since

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ers.") (quoting Edward W. Cleary, *Preliminary Notes on Reading the Rules of Evidence*, 57 NEB. L. REV. 908, 915 (1978)) (internal quotation marks omitted).

80. *Daubert*, 509 U.S. at 588; FED. R. EVID. 402.

81. *Daubert*, 509 U.S. at 588.

82. FED. R. EVID. 702.

83. *Daubert*, 509 U.S. at 588–89.

84. *Id.* at 597.

85. *Id.*

86. *Id.* at 593–94.

87. *Id.* at 597.

replaced the *Frye* general acceptance standard in determining the admissibility of scientific evidence in federal courts.[88]

Regardless of whether a court applies the *Frye* or *Daubert* standard, it is difficult to predict whether a given court will admit neuroimaging evidence to prove pain and suffering due to the relative novelty of using the technology in this way and the paucity of case law on point. However, courts' responses to neuroimaging evidence to prove different injuries, as well as decisions regarding its admissibility in lie detection, may prove instructive.

A. Admissibility Under Frye*'s General Acceptance Standard*

Although the Court in *Daubert* held that FRE 702 superseded the *Frye* standard for federal trials, the general acceptance standard is still used in a fairly large number of state courts.[89]

For example, a New York state court expressly refused to apply the *Daubert* factor test, even at the request of the defendant, and instead applied the general acceptance standard to the use of a PET scan expert in a personal injury case.[90] After the plaintiff had offered an expert's testimony in order to support her allegation that she suffered minor brain trauma when a piece of her bathroom ceiling collapsed on her head, the defendant filed a motion attempting to exclude the expert's testimony, asserting that the use of PET scans to diagnose brain injury is not generally accepted in the medical field.[91] The trial judge found that the PET scan satisfied the general acceptance standard and denied the defendant's motion, allowing the jury to hear the expert's testimony with regard to the PET scan results.[92]

Conversely, in *State v. Smith*, a Maryland trial judge refused to allow fMRI evidence in a criminal case under the *Frye* standard.[93] The judge in this case was faced with the decision of whether to admit fMRI scans as evidence that the defendant was telling the truth—a modern neurological polygraph test.[94] Here, the defendant submitted testimony

88. *See id.*

89. *Id.* at 594; *see* FED. R. EVID. 702 Advisory Committee Notes. *See generally* Alice B. Lustre, Annotation, *Post*-Daubert *Standards for Admissibility of Scientific and Other Expert Evidence in State Courts*, 90 A.L.R. 5th 453 (2001) (discussing state cases in which courts have applied *Daubert*, *Frye*, or some other test in determining the admissibility of expert testimony regarding scientific, technical, or other specialized knowledge).

90. Brown v. Allerton Assocs., No. 17917/03, 2006 WL 3102331, at *1–3 (N.Y. Sup. Ct. Oct. 5, 2006).

91. *Id.* at *1–2.

92. *Id.* at *1, 3.

93. *See* Memorandum Opinion and Order, State v. Smith (Md. Cir. Ct. Oct. 3, 2012) (No. 106589C), *available at* http://www.lawneuro.org/_resources/pdf/fMRIOpinion.pdf.

94. *Id.* at 1.

and research articles in support of his request to admit the results of the fMRI that was conducted on him.[95] The defendant argued that "the fMRI methodology used for lie detection and truth verification is generally accepted in its relevant scientific community, as shown through the 'totality of published scientific literature on the topic.'"[96] Although the defendant presented twenty-five peer-reviewed scientific journal articles on the fMRI lie detection and truth verification method, the court was "not swayed by that number when considering the depth of scientific analysis done in a particular area[,]"[97] implying that because other areas of science have a greater body of research, twenty-five articles was insufficient. Further, though none of the submitted articles concluded that the technology does not work, the court was "not persuaded that the fact that there is no evidence a scientific method does 'not work' is evidence that it is reliable and valid."[98] Importantly, and instructive for future litigants, the court noted that "the standard required for admissibility in a court of law is higher than the method simply not working."[99] The court further noted that "[t]here must be evidence of the method's reliability and validity as determined by its general acceptance in the relevant scientific community," and that the "tepid approval of a few scholars through twenty-five journal articles does not persuade this Court that such acceptance exists."[100]

Thus, as these cases illustrate, although the *Frye* standard requires general acceptance in the scientific community, the admissibility of evidence still largely comes down to the broad discretion of the judge as to what exactly constitutes general acceptance. *Smith* in particular illustrates the resistance to admitting unfamiliar scientific evidence such as fMRI into the courtroom. Although every journal article brought to the court indicated that the method was reliable, the court still refused to admit the evidence because the judge simply did not feel that twenty-five scholarly articles was sufficient.[101]

What, then is needed in order to achieve general acceptance? The answer is impossible to predict because it depends on the fortification of each judge's scientific evidence gate. FMRI evidence of pain and suffering is unlikely to fare any differently. Indeed, the problem with the *Frye* standard is that it "exclude[s] cutting-edge scientific evidence that might be [1] both relevant and reliable under traditional legal standards but

95. *Id.* at 4.
96. *Id.*
97. *Id.*
98. *Id.*
99. *Id.*
100. *Id.*
101. *See id.*

[2] [i]s not yet widely accepted by scientists."[102] The *Daubert* standard, however, may prove friendlier to this type of evidence due to its distancing from the general acceptance standard.

B. Admissibility Under the Daubert *Standard and the Federal Rules of Evidence*

Under the *Daubert* standard, neuroimaging evidence has been similarly met with skepticism. In *United States v. Semrau*, the Sixth Circuit Court of Appeals was faced with the decision of whether to affirm or reverse a trial court evidentiary decision similar to that of the Maryland trial judge in *Smith*.[103] As in *Smith*, the lower court in *Semrau* refused to admit expert testimony regarding fMRI truth verification testing in its *Daubert* hearing.[104] The *Semrau* court affirmed the trial court's exclusion of this evidence in affirming the defendant's conviction for healthcare fraud.[105] The court reasoned in part that, pursuant to FRE 403,[106] the fMRI evidence's probative value was substantially outweighed by its prejudicial nature.[107] In a footnote, the court stated, "[t]he prospect of introducing fMRI lie detection results into criminal trials is undoubtedly intriguing and, perhaps, a little scary."[108] Again, this illustrates courts' reluctance to accept newfangled neuroimaging evidence. Because the *Daubert* admissibility formulation is dependent on an individual judge's discretion, it is difficult to predict whether a particular court applying the *Daubert* standard will allow evidence of this type into its courtroom.

In contrast to *Semrau*, in *In re Welding Fume Products Liability Litigation*, the Federal Northern District of Ohio in its *Daubert* hearing admitted several of the defendant's neuroscientific experts' testimonies to rebut the plaintiff's claim that their manganese fumes caused neuro-

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102. 29 CHARLES ALAN WRIGHT & VICTOR JAMES GOLD, FEDERAL PRACTICE AND PROCEDURE § 6266, at 265 (1997).

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

104. *Id.* at 531.

105. *Id.*

106. FRE 403 provides "[t]he court may exclude relevant evidence if its probative value is substantially outweighed by a danger of one or more of the following: unfair prejudice, confusing the issues, misleading the jury, undue delay, wasting time, or needlessly presenting cumulative evidence." FED. R. EVID. 403.

107. *Semrau*, 693 F.3d at 524. Specifically, the court held "that the district court did not abuse its discretion in excluding the fMRI evidence pursuant to FRE 403 in light of (1) the questions surrounding the reliability of fMRI lie detection tests in general and as performed on Dr. Semrau, (2) the failure to give the prosecution an opportunity to participate in the testing, and (3) the test result's inability to corroborate Dr. Semrau's answers as to the particular offenses for which he was charged." *Id.*

108. *Id.* at 524 n.12.

logical injuries.[109] The defendant's evidence, which included MRI and PET scans, allegedly established that there was no causal link between manganese and the claimed neurological injuries.[110] In reliance on their evidence, the defendant filed a motion to exclude all testimony that refuted their experts' interpretations of the neurological scans.[111] The court denied the motion, reasoning that although the defendant's evidence was convincing, it could not prove dispositively the causation or lack thereof.[112]

Because admissibility is left solely to the discretion of the judge—the "gatekeeper" of evidence—it is less relevant whether the submitted methodology is generally accepted in the community and more relevant that the methodology proves accurate. Thus, it seems that neuroimaging evidence may more easily enter the courtroom under the *Daubert* standard.

III. POTENTIAL FUTURE USE

Because most of the cases in which courts admit neuroimaging evidence are unreported, the gap in the legal community's knowledge of how to use this evidence, and whether they even can use this evidence, is growing instead of shrinking. This Part first examines two cases in which neuroimaging evidence was admitted, and then moves on to describe the uses and problems with the use of neuroimaging evidence in civil litigation.

A. Two Promising Cases Using SPECT and fMRI

Although there is a notable gap in reported cases, one of the first reported cases in which neuroimaging evidence was admitted was a Ninth Circuit case, *Boyd v. Bert Bell/Pete Rozelle NFL Players Retirement Plan*.[113] This case illustrates the problems that plaintiffs face in attempting to gain disability benefits for nontraditional physical injuries, and the potential assistance that neuroimaging evidence can provide. In *Boyd*, many of the plaintiff's symptoms, such as headaches and fatigue, were not physically manifested.[114]

This rather well-known case centered on one of the first suits brought against the National Football Association for degenerative disa-

109. *See In re* Welding Fume Prods. Liab. Litig., No. 1:03-CV-17000, 2005 WL 1868046, at *31 (N.D. Ohio Aug. 8, 2005). This is the trial court's *Daubert* hearing order. The case was later reported as *In re* Welding Fume Prods. Liab. Litig., 526 F. Supp. 2d 775 (N.D. Ohio 2007).

110. *Welding Fume Prods. Liab. Litig.*, 2005 WL 1868046, at *31.

111. *Id.*

112. *Id.* at *30–31.

113. Boyd v. Bert Bell/Pete Rozelle NFL Players Ret. Plan, 410 F.3d 1173 (9th Cir. 2005).

114. *Id.* at 1175.

bility benefits under the Bert Bell/Pete Rozelle National Football League Player Retirement Plan (the Plan).[115] The Plan provides disability, retirement, and other benefits to eligible current and former National Football League (NFL) players.[116] The plaintiff, Brent Boyd, was an offensive lineman for the Minnesota Vikings from 1980 to 1987.[117] In 2000, Boyd filed his second application for football degenerative disability benefits under the Plan, claiming benefits based on alleged organic brain problems resulting from head trauma.[118] His symptoms included "a general constant flu-like feeling, fatigue, headaches, queasiness, forgetfulness, intermittent blurred vision, difficulty reading, lack of concentration, learning difficulty, memory loss, dizziness and light-headedness."[119] The district court granted summary judgment in favor of the NFL on the grounds that the plaintiff could not prove his alleged brain injuries.[120]

The physician for the Plan concluded from his examination that the plaintiff "[did] appear to have several problems that may arise out of head injuries suffered in the course of his NFL career."[121] At Boyd's request, a second physician conducted a SPECT scan[122] on Boyd, and the scan revealed decreased brain activity consistent with head trauma.[123] This evidence was admitted into court under the federal *Daubert* standard, as interpreted by an expert.[124] The results of the SPECT were referred to another physician whose medical conclusions were admitted into court.[125] Unfortunately for Boyd, this physician concluded that "[b]ased on the evidence available, the alleged head injury of August, 1980 could not be organically responsible for all or even a major portion of the neurologic and/or neuropsychologic problems that Mr. Boyd is experiencing now, to a reasonable degree of medical probability[,]" and this "include[d] the allegedly abnormal SPECT scan results in this category."[126]

Although in Boyd's case the neuroscientific evidence worked against him, in future cases this type of evidence may help plaintiffs with similar injuries, and in all likelihood, will even be used by current and

115. *Id.* at 1174.
116. *Id.*
117. *Id.*
118. *Id.* at 1175.
119. *Id.*
120. *Id.* at 1174.
121. *Id.* at 1176.
122. *See supra* Part I.A.
123. *Boyd*, 410 F.3d at 1177.
124. *Id.* This is generally the way neuroscientific evidence is admitted into the courtroom due to the potential for the images to mislead the jury if admitted without an expert's explanation.
125. *Id.*
126. *Id.*

former NFL players to collect football degenerative benefits for brain injuries sustained during their time in the league.

In contrast, the plaintiff in *Koch v. Western Emulsions Inc*. was able to benefit from the admission of fMRI evidence to prove his pain.[127] Carl Koch sued his former employer, Western Emulsions, for damages arising out of a 2005 work incident which resulted in Koch burning his wrist with molten asphalt.[128] When the suit was filed in 2006, Koch still allegedly had chronic pain in his wrist.[129] In order to prove the pain, he had an fMRI performed on him at the fMRI Research Center at Columbia University.[130] The neuroscientist at the Research Center believed she had developed a method that would allow her to visualize chronic pain via fMRI.[131] When she lightly touched Koch's injured wrist, the stimulus provoked a signal in the pain matrix, while lightly touching the other unaffected wrist did not.[132] The neuroscientist performing the test stated that this methodology "is a well-characterized way to distinguish allodynia—a pain response to a stimulus that does not normally cause pain—from imagined pain."[133] The case unsurprisingly turned into a battle of the experts.[134]

At trial, the defendants called a neurologist of their own to the stand who testified that pain is too subjective to measure in this way, and that the signal seen on the scan could be produced by imagining the pain or concentrating on it.[135] In the end, the trial judge admitted the scan, which contributed to the case settling for $800,000, a sum that, according to Koch's lawyer, was over ten times the defendant's initial settlement offer.[136] Armed with an fMRI scan allegedly corroborating his claims of wrist pain, Koch was able to gain a more favorable settlement offer and settle before the conclusion of the trial.[137] Thus, the trial court judge's discretion in admitting the neuroimaging evidence was instrumental to the final disposition of the case.

127. Sara Reardon, *Neuroscience in Court: The Painful Truth*, 518 NATURE 474, 475 (2015).
128. *Id.*
129. *Id.*
130. *Id.*
131. *Id.*
132. *Id.*
133. *Id.*
134. *See id.*
135. *Id.*
136. *Id.*
137. *See id.*

B. Future Uses and Problems with Use in Civil Litigation

Irrespective of whether a court applies the *Frye* or *Daubert* standard, it is clear that given the current schism in the scientific community as to its reliability and accuracy, as well as the corresponding potential prejudice that might be wrought upon its admission, courts are presently resistant to admitting neuroimaging evidence. However, the persistent development of pain-detecting neuroimaging will lead to increasing demand for these scans and an increasing number of litigants moving to admit neuroimaging evidence into court. Similarly, the continually advancing technology and its growing acceptance in the scientific community will inevitably increase the courts' confidence in admitting this evidence. But as the admission of neuroimaging evidence becomes more common, new issues will arise.

Plaintiffs and defendants alike will increasingly gravitate toward the use of this evidence, whether the technology is reliable or not. The human tendency is to give greater weight to evidence we can see with our own eyes. Indeed, for many, seeing is believing. Regardless of whether the scans are accurate and reliable, fact finders may tend to place trust in the scans simply because they will be impressed by the colorful images of the subject's brain and because the scans intuitively seem like objective science. Accordingly, litigants will likely secure neuroimaging scans in attempts to support or defend against claims of pain and suffering on the chance that the trial judge will admit the scan into evidence. Although in some cases, like *Boyd*, the evidence may actually have a detrimental effect, many will likely move to admit the evidence anyway; the battle of the experts always brings with it a gamble. It is thus fair to predict that as this technology develops further, litigants' use of favorable pain scans will almost undoubtedly become correspondingly common due to the hope that the neuroimaging evidence will sway the minds of the fact finders in the litigants' direction. Regardless of the frequency with which litigants move to admit this evidence, however, courts should remain wary to admit it.

Neuroimaging evidence of pain and suffering—particularly fMRI—is approaching the level of reliability necessary for use in a courtroom, and it may be that it enters the courtroom with relative regularity within the next decade. It is clear that researchers have made drastic strides in discovering and assessing the brain's pain matrix.[138] As this research becomes more accepted, judges using the *Frye* standard will be more likely to admit it under the general acceptance standard. Likewise, courts using the *Daubert* standard will be more apt to accept the evidence with the

138. *See supra* Part I.C.

comfort that the body of research surrounding neuroimaging and pain is growing. A scientific method's general acceptance in the scientific community seems to bear an inverse relationship to courts' fear of prejudice wrought by the admission of that evidence. Thus, as the body of research grows, courts' acceptance will correspondingly increase.

At present, however, the scientific community is divided as to the validity of pain neuroimaging technology.[139] Until the greater scientific community supports the methodology and neuroimaging scans can provide a truly objective framework for limiting the broad discretion of the fact finder in awarding pain and suffering damages, courts will be—and should be—wary to admit neuroimaging scans.

CONCLUSION

There is no simplified or expedited path that will fast track the admittance of neuroimaging evidence of pain and suffering into the courtroom. FMRI pain scans, though close to general acceptance, still do not produce the requisite level of certainty to make them useful in the courtroom. For injuries that lack physical proof, a plaintiff's word will still carry overwhelming weight in fact finders' determination of pain and suffering awards.

Courts are understandably uncomfortable with accepting unproven technology to prove questions of fact. Although the method has developed and increased in reliability and use in the last two decades, at this point it is not an agreed-upon valid method to show pain, and judges have little precedent to rely on in admitting the scans as evidence. It will take bold judges like the judge in *Koch* to allow this evidence to bolster claims of pain and suffering. But as the technology becomes more reliable and generally accepted, the question we must all ask ourselves is whether we want a human fact finder or a machine deciding whether we are in pain.

139. *See supra* Part I.D.