Journal of Health Care Law and Policy

Volume 18
Issue 2 *Imaging the Brain, Changing Minds: Chronic Pain Neuroimaging and the Law*

Article 4

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PANEL 2: "EXCESS" PAIN, HYPERALGESIA, AND THE VARIABILITY OF SUBJECTIVE EXPERIENCE

AMANDA PUSTILNIK, DAVE SEMINOWICZ, AND STEPHEN RIGG

SPEAKERS: JOEL GREENSPAN,* JUDGE MORRIS HOFFMAN,** ADAM KOLBER,*** AND MICHAEL PARDO****

Pain is everywhere: It's the most salient and, in many ways, the most difficult of the legally salient emotions.
Judge Morris Hoffman

I. INTRODUCTION

The second panel of the conference, focusing on "excess pain," addressed issues relating to scientific findings of the individual variability of pain experience and pain perception, which is in contrast to the legal presumption that there is a specific amount of pain that ought to be typical for particular conditions.[1] The panel represented a great breadth of

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experience, consisting of a pain researcher, a sitting judge, a legal scholar in the field of evidence law, and a legal scholar in the field of law and neuroscience.[2]

Professor Joel D. Greenspan, PhD spoke first about the variability of individual pain experience. He described the range of individual pain variation, and some of the genetic and neuroendocrine influences thereon.[3] For the benefit of the attorneys and other non-scientists in attendance, he provided a brief seminar on how pain is perceived, how pain becomes chronic, and how clinicians measure and assess pain.[4] This provided a sound foundation for discussions later in the panel that related to the perception and detection of chronic pain.[5]

The Honorable Morris Hoffman,[6] a frequent commentator on law and neuroscience and a founding member of the MacArthur Law & Neuroscience Project, spoke on the ways in which legal doctrines and legal actors struggle with issues relating to pain.[7] He introduced several key themes: the variability of pain itself combined with the variability that decision makers (like judges and jurors) have in being able to understand the pain of others; the composite nature of pain as both a physical phenomenon and a narrative experience that has meaning within the context of an individual's life; and the difficulties of " mind-reading," which are

**** Professor of Law, Univ. of Ala.; Former Chair, Am. Ass'n of Law Schs. Section on Evidence. *See* Michael S. Pardo, *Curriculum Vitae*, U. ALA. SCH. LAW, http://www.law.ua.edu/directory/files/cv/Pardo-Michael%20S.-cv.pdf (last revised Feb. 1, 2015).

1. Joel Greenspan, Adam Kolber, & Michael Pardo, Imaging the Brain, Changing Minds: Chronic Pain Neuroimaging and the Law Symposium, Panel 2: "Excess Pain," Hyperalgisia, and the Variability of Subjective Experience (Apr. 25, 2014) [hereinafter Panel 2] (transcript on file with the editors).

2. *Id.*

3. *Id.* at 3–4.

4. *Id.*

5. *See generally* Jennifer Chandler, Robert Dinerstein, Jennifer A. Haythornthwaite, Tor D. Wagner, Imaging the Brain, Changing Minds: Chronic Pain Neuroimaging and the Law Symposium, Panel 3: Chronic Pain, "Psychogenic" Pain, and Emotion (Apr. 25, 2014) [hereinafter Panel 3] (transcript on file with the editors) (expanding on issues that distinguish among organic, social, emotional, physical, real, and imagined kinds of pain in both the research and legal context).

6. Denver Dist. Ct.; Adjunct Professor, Univ. of Colo. at Boulder; Member, MacArthur Found. Research Network on Law & Neuroscience. *See The Honorable Morris Hoffman*, U. MD. FRANCIS KING CAREY SCH. LAW, http://www.law.umaryland.edu/faculty/conferences/conf166/speakers/Honorable_Morris_Hoffman.pdf (last visited Mar. 15, 2014); *Morris B. Hoffman – 2nd Judicial District Court Judge*, COLO. JUD. BRANCH, http://www.courts.state.co.us/Bio.cfm?Employee_ID=558 (last visited Mar. 15, 2015).

7. Panel 2, *supra* note 1, at 9–10 (attributing the difficulties in dealing with pain in the law to three sources: the enormous variability of pain, that memory and pain are conflated, and that the law fails to emphasize certain kinds of pain).

present in relation to many legal determinations, but which may be particularly acute in relation to pain and suffering.[8]

Professor Michael Pardo, a professor of evidence law who has published widely in the areas of law and neuroscience and who is a philosophy of law, offered his views on the considerations involved in whether to admit neuroscience based evidence of chronic pain. He first offered legal and theoretical considerations that pertain to scientific evidence in general, and then provided specific insights relating to the neuroscience based evidence of pain.[9] He framed his remarks by noting that while he would address the law of evidence specifically, including factors like the Federal Rules of Evidence and the *Daubert* test for expert evidence, the issues in evidence law go beyond the Rules.[10] Further, he contended that it is necessary to evaluate the normative goals of the legal system in relation to its institutional competencies and the ways in which legal actors and lay people engage in decision making as we consider how scientific evidence may or may not enhance the legal process.[11]

Professor Adam Kolber noted that pain neuroimaging might cause the law to consider subjective differences in perception in a range of areas.[12] Beyond disability and tort, he suggested that the law might need to consider subjective differences in the experience of punishment in criminal law.[13] He also discussed problems with conventional pain rating scales, suggesting ways that the use of pain neuroimaging could supplement these traditional measures.[14]

Overall, the panel described how chronic pain diseases disturb healthy, typical pain processing in ways that involve the peripheral nervous system and the brain, making legal expectations about typical or expected degrees of pain misguided in the context of chronic pain disorders.[15] Neuroimaging

8. *Id.*

9. *Id.* at 18–19 (describing the difficulties in ascertaining the goals of expert testimony as well as the difficulties with evidence regulation policies).

10. *Id.* at 19–20 (explaining the arguments for and against both strict and lax evidence policy regulation); *see also* Michael Finch, *Law and the Problem of Pain*, 74 U. CIN. L. REV. (2011) (highlighting the difficulties in relying on subjective chronic pain evidence of fibromyalgia in the absence of objective evidence availability).

11. Panel 2, *supra* note 1, at 18–20.

12. *Id.* at 6–8; *see generally* Adam J. Kolber, *The Experiential Future of the Law,* 60 EMORY L.J. 585, 588 (2011) (discussing the ability to assess subjective pain perceptions in (1) a patient in a persistent vegetative state, (2) a subject receiving a placebo treatment relieving pain, (3) an alleged victim of child abuse, (4) an inmate undergoing an execution, and (5) an interrogation allegedly consisting of torture).

13. Panel 2, *supra* note 1, at 6–7; *see also* Alison K. Bennett & Jason Bloom, *Neurolaw Brain Waves in the Courtroom*, 75 TEX. B.J. 280 (2012) (discussing the implications for juror decision making in criminal law in light of recent neuroimaging technology).

14. Panel 2, *supra* note 1, at 6, 8.

15. *Id.*

shows that people's self reports about how much pain they feel matches the degree of brain activation in key pain regions.[16] This provides proof of a foundational concept: subjective self reports match brain activity or, in other words, phenomenology correlates with physiology.[17] Put more simply: when people complain of different degrees of pain in response to the same stimulus, they are reporting on real variation—it is not merely that they have different styles of self expression.[18]

The panelists agreed that evidence of individual pain intensity is not yet available through neuroimaging, particularly for chronic pain.[19] Yet, neuroscientific evidence about pain variability is available, which provides a framework; neuroscientific evidence could potentially be used to inform a range of people from decision makers to lawmakers to jurors about how chronic pain arises and how it affects those who suffer from it.

Panelists emphasized that accepting the notion that there may be no such thing as typical pain does not mean that the legal system needs to take all pain claims at face value.[20] There are various ways of testing and corroborating how much pain a person is experiencing.[21] Accepting that there is no such thing as a typical or reasonable amount of pain does mean that legal decision makers should start from different baseline expectations. The expectation should be that the decision maker has to make a factual finding about how much pain this claimant is experiencing in light of all the evidence—not merely to make a relative finding about whether this claimant has more pain than the decision maker would "expect."

16. Robert C. Coghill, Individual Differences in the Subjective Experience of Pain: New Insights into Mechanisms and Models 2 (Oct. 1, 2011) (subsequently published) (on file with NIH), *available at* http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2959190/pdf/nihms231860.pdf. These tests were completed in a laboratory setting where the subjects have no incentive to fabricate. *Id.*

17. *Id.*

18. *Id.*

19. Panel 2, *supra* note 1, at 8, 13–14, 18.

20. *Id.* at 11–12. *See also* Jerel C. Dawson, *The Conundrum of Self-Reported Symptoms*, LIFE, HEALTH & DISABILITY, Sept. 2008, at 70, 71 (explaining that in ERISA claims, the administrator must consider the possibility that applicants are exaggerating).

21. *See* Robert J. Gatchel et al., *The Biopsychosocial Approach to Chronic Pain: Scientific Advances and Future Directions*, 133 PSYCHOL. BULL. 581, 585 (2007) (describing different techniques for visually identifying inflammatory pain).

II. PAIN EXPERIENCE AND DETECTION: PAIN IS HIGHLY VARIABLE, AND "REASONABLE" PAIN IS NOT CLINICALLY MEANINGFUL

A. Pain Is Highly Variable: Pain Levels and "Excess" Pain

Professor Greenspan addressed the question of levels of pain, and was joined in discussion by conference participants Professors Karen Davis and Jennifer Haythornthwaite.[22] They described a range of influences on patients' experience of pain, including medical, genetic, phenotypic, and social-psychological factors.[23] The panel involved a discussion of kinds (or categories) of chronic pain and pain experience that can involve unusual or amplified pain sensation, including the conditions of hyperalgesia and allodynia.[24] Professor Greenspan and other participants also discussed common pain evaluation techniques.[25] The conclusion of the discussion amongst these pain researchers is that the common legal designation of "excess" or "unreasonable" pain is not clinically meaningful, and tends to be misleading.[26] This section of the panel sought to explain mechanisms for normal and abnormal pain processing and the tools used to quantify pain perception.[27]

Professor Greenspan first discussed the broad range of normal responses to a painful stimulation.[28] He then addressed the question of how to evaluate whether a patient has unusual or "excess" pain in relation to the difficulty of establishing a "typical" or "normal" pain baseline.[29] Professor Greenspan remarked that in order "to decide what's excess pain or what is hyperalgesic pain, you have to kind of know where [the] cutoff[s] [are at each end for unusually low or high sensitivity], and that's not easy to do." The big problem becomes deciding what is more than standard pain.[30] He noted that there would be a very wide range of responses in any study that would apply a painful stimulus to people without a pain problem.[31] Accordingly, "clinically speaking . . . [it is difficult to decide] if someone

22. Panel 2, *supra* note 1, at 3–4. Professor Greenspan's original comments have been augmented here beyond the constraints of what the one hour panel permitted.

23. *See, e.g.*, *id.* at 18 (explaining that contributions to pain variability include differences in the type of injury, existence of mental coping mechanisms, and varying behavioral repertoire).

24. *Id.* at 3–5.

25. *Id.* at 1–5, 14, 22, 24.

26. *Id.* at 8.

27. *See generally id.*

28. *Id.* at 3–4 (noting that in a sample group, people will interpret pain at different levels, which suggests a wide range of sensitivity).

29. *Id.*

30. *Id.*

31. *Id.* at 14.

has an abnormal pain sensitivity."[32] Because the range of normal sensitivity is so broad, most researchers and clinicians believe that defining abnormal sensitivity as being totally outside a range of normal sensitivity is too stringent a criterion.[33]

Professor Greenspan noted that clinicians develop a sense (through experience) of how a range of patients with conditions like lower back pain might respond to evoked pain in cases where the clinician applies some kind of stimulation to the patient.[34] Based on clinicians' experience of how a broad sample of patients has reacted, clinicians can characterize if a patient has abnormal sensitivity.[35] This observation by Professor Greenspan introduced what would become a theme of the panel: the idea of dual variability.[36] Patients vary both in their sensitivity to pain and in the ways that they report pain.[37] Additionally, clinicians, who have differing kinds and levels of experience as well as differing normative commitments concerning pain might also vary in their interpretation of a patient's report of pain.[38] Thus, one clinician might find a patient's report to be within the range of normal sensitivity while another clinician might determine that the same patient is abnormally sensitive.

Professor Greenspan remarked that "the basic question" for clinicians, and often for legal actors, is determining "what is 'excess pain' and how . . . this relate[s] to the question of what is 'hyperalgesia'"—a specific form of unusual pain sensitivity.[39] Hyperalgesia is a clinical term that describes an

32. *Id.* at 4.

33. *Id.*

34. This form of testing is appropriate to some forms of chronic pain, like lower back pain or arthritic pain, but not to others, including chronic headache or irritable bowel syndrome. *Id.* at 3–5; *see also* David A. Seminowicz et al., *Effective Treatment of Chronic Low Back Pain in Humans Reverses Abnormal Brain Anatomy and Function*, 31 J. NEUROSCIENCE 7540, 7541 (2011) (noting a study that recruited low back pain patients for pain evaluation through stimulation); David A. Seminowicz et al., *Regional Gray Matter Density Changes Brain Patient with Irritable Bowel Syndrome*, 139 GASTROENTEROLOGY 47, 54–55 (2010) (noting a study that analyzed irritable bowel syndrome patients' responses to pain stimulation); Clifford J. Woolf, *Central Sensitization: Implications for the Diagnosis and Treatment of Pain*, 152 J. PAIN S2, S7–S9 (2011) (discussing pain sensitization in patients with rheumatoid arthritis, osteoarthritis, headaches, and irritable bowel syndrome).

35. Panel 2, *supra* note 1, at 3–5.

36. *Id.* at 4–5.

37. *See, e.g.*, William Maixner et al., *Orofacial Pain Prospective Evaluation and Risk Assessment Study – The OPPERA Study*, 11 J. PAIN T4, T4–T6 (2011) (discussing factors that influence pain sensitivity and how these factors affect patients).

38. Panel 2, *supra* note 1, at 5–6; *see also* Keith Smart & Catherine Doody, *The Clinical Reasoning of Pain by Experienced Musculoskeletal Physiotherapists*, 12 MANUAL THERAPY 40, 48 (2007) (noting that future research may address varying levels of experience in relation to clinical reasoning of pain).

39. Panel 2, *supra* note 1, at 3.

increased or heightened response to some painful stimulus.[40] It is present when a patient is tested with some painful stimulus, which causes the patient more pain than typically expected.[41] Pain amplification of this kind can occur through several well studied mechanisms.[42] Pain amplification can occur "peripherally" (i.e., locally—at the site of the painful stimulation) because the nerves in that location have become sensitized.[43] For example, lightly rubbing the skin with rough sandpaper ordinarily might be moderately painful. Applying the same stimulus to skin that has been sensitized with a burning capsaicin based cream would result in significantly more pain (i.e., locally induced hyperalgesia).[44] Pain amplification can also occur in the spinal cord.[45] This occurs when there is a heightened transmission of the pain signal from the peripheral pain sensing nerves to the dorsal horn of the spinal cord, which then sends the signal up to the brain, resulting in a kind of a megaphone effect.[46] Finally, pain sensing and transmission can be unaltered both locally and in the spinal cord, but it then can be amplified in certain regions of the brain, such as in the thalamus following a stroke.[47] These three paths to hyperalgesia can exist independently or in combination.[48]

Determining whether a patient is unusually sensitive in response to a specific, painful stimulus is challenging.[49] Yet, making such a determination becomes much more challenging to determine abnormal

40. *Id.*; *see also IASP Taxonomy*, INT'L ASSOC. FOR STUDY PAIN, http://www.iasp-pain.org/Taxonomy (last updated May 22, 2012) (defining hyperalgesia as "diminished pain in response to a normally painful stimulus," which is distinguishable from allodynia, which is "pain due to a stimulus that does not normally provoke pain").

41. *See* sources cited *supra* note 40.

42. *See* Clifford J. Woolf & Michael Salter, *Neural Plasticity: Increasing the Gain in Pain*, 288 SCIENCE MAGAZINE 1765, 1766 (2000) (describing peripheral terminals of nociceptors with activation of nociceptive transducer receptor/ion channel complexes, activity dependent plasticity, tissue damage/inflammation, and neuropathic pain by nervous system lesions as mechanisms contributing to pain); Smart & Doody, *supra* note 38, at 41 (noting that five categories of pain mechanisms include: (1) nociceptive; (2) peripheral neurogenic; (3) central pain; (4) autonomic and motor mechanisms; and (5) affective mechanisms).

43. *See* Woolf & Salter, *supra* note 42 (noting that physiological pain occurs at the "peripheral[] terminals of nociceptors").

44. Jaquette Liljencrantz et al., *Altered C-Tactile Processing in Human Dynamic Tactile Allodynia*, 154 J. PAIN 227, 228 (2013) (discussing a study in which participants had capsaicin cream applied to their skin in order to analyze hyperalgesia and allodynia).

45. Woolf, *supra* note 34, at S3 (noting that pain hypersensitivity in patients occur and can be produced in the spinal cord).

46. *Id.*

47. *Id.* at S3, S8.

48. *See* Woolf & Salter, *supra* note 42, at 1765 (noting that pain comprises three categories: physiological, inflammatory, and neuropathic pain).

49. Panel 2, *supra* note 1, at 4 (finding difficulty in determining whether a person has abnormal pain sensitivity).

sensitivity in relation to non-evoked pain—that is, ongoing or chronic pain, which may exist independently of any particular stimulation.[50] He noted that, "in the context of not being able to provoke the pain . . . [but rather in dealing] with a person's ongoing pain . . . we have even less of a sense of how accurately they're reporting what they're feeling and how their use of the numbers [to rate the intensity of pain might] reflect[] a larger population's use of numbers" for the same injury or disorder.[51] Accordingly, in both clinical and research settings, Professor Greenspan noted that "we typically try . . . a variety of different approaches to get at an assessment of pain sensitivity and look for concurrence of reporting, doing testing multiple times, or doing different types of testing, where you would expect a consistent picture to come if the person is consistently reporting what they're saying they're feeling."[52]

In addition to hyperalgesia, patients suffering from chronic pain frequently experience spontaneous pain.[53] It is most clearly exemplified in the case of central pain, where a lesion to the spinal cord or brain is present, but spontaneous pain is often reported in many chronic pain conditions.[54] The pain is usually localized to an area of the body, despite there being no evident injury or activation of peripheral nerves from that body part.[55] Spontaneous pain appears to happen in the absence of an external stimulus.[56] It is unclear whether the pain is actually spontaneous or whether it is evoked by abnormalities whose nature or cause is not determinable by using current techniques.[57] Regardless of its cause, spontaneous pain is often the most debilitating and frustrating symptom for patients.[58] Since

50. *Id.* at 5.

51. *Id.*

52. *Id.*

53. *See generally* Gary J. Bennett, *What is Spontaneous Pain and Who Has It?*, 13 J. PAIN 921, 927 (2012) (distinguishing chronic pain, spontaneous pain, and pain from temporally summated hypersensitivity); Jeffrey S. Mogil, *The Etiology and Symptomatology of Spontaneous Pain*, 13 J. PAIN 932, 932 (2012) (suggesting that "spontaneous" should be understood as a way of characterizing the symptomatology rather than the etiology of pain); John D. Loeser, *Chronic Pain is More Than a Peripheral Event*, 13 J. PAIN 930, 930–31 (2012) (noting that the term "spontaneous" is misleading because there is always a physiological process that underlies the report of pain).

54. Bennett, *supra* note 53, at 923, 924, 926.

55. *See generally* Loeser, *supra* note 53, at 930 ("It is not relevant that we sometimes cannot find the site at which the nociception originates or determine a proximate stimulus.").

56. *See generally* Bennett, *supra* note 53, at 922 (asserting that spontaneous pain is the result of neuronal changes in the somatosensory system).

57. *See* Mogil, *supra* note 53, at 932–33 (questioning clinical failures to elicit neuropathic pain patients' hypersensitivity state in laboratory settings).

58. *See e.g.*, Andrew Davies et al., *Breakthrough Cancer Pain: An Observational Study of 1000 European Oncology Patients*, 43 J. PAIN & SYMPTOM MANAGEMENT 619, 626–27 (2013) (asserting that spontaneous pain in cancer patients is a significant cause of morbidity, leading to disruptions in sleep and mood).

there is no apparent direct cause of spontaneous pain, it is not possible to calibrate such pain as greater or lesser than would be expected for the stimulus or condition.

To someone with chronic pain, the experience of pain itself might be different than that of healthy people, which might be associated with differences in brain activity.[59] This has been clearly demonstrated in two studies that came from A. Vania Apkarian's lab.[60] In the first study, researchers showed that the nucleus accumbens, an area typically associated with reward processing, was activated in healthy subjects with pain relief; but in chronic back pain patients, it was activated during the experimental pain itself, suggesting that it provided relief from the ongoing back pain. [61] In other words, the typically painful stimulus was an analgesic. In a later study by the same group, they showed that the transition from subacute to chronic pain is associated with a greater involvement of emotion related brain areas during pain.[62] These studies suggest that in chronic pain, the experience of pain takes on new meaning—in healthy people, pain is a warning signal that activates mostly sensory and cognitive brain areas, but in chronic pain patients, spontaneous pain might be experienced as punishing.[63]

Pain that is directly linked to a disease state is usually indicated as pain from that condition rather than a chronic pain disorder *per se*.[64] For example, pain associated with cancer is typically referred to as cancer pain, or "chronic cancer pain" when the pain from the disease persists beyond six months.[65] In those cases, the assumption is that the pain is directly linked to

59. Panel 2, *supra* note 1, at 14.

60. *See* Marwan N. Baliki et al., *Predicting Value of Pain and Analgesia: Nucleus Accumbens Response to Noxious Stimuli Changes in the Presence of Chronic Pain*, 66 NEURON 149 (2010) (finding that the nucleus accumbens, an area typically associated with reward processing, was activated in healthy subjects with pain relief, but in chronic back pain patients, it was activated during the experimental pain itself, suggesting that it provided relief from the ongoing back pain); Javeria A. Hashmi et al., *Shape Shifting Pain: Chronification of Back Pain Shifts Brain Representation from Nociceptive to Emotional Circuits*, 136 BRAIN 2751 (2013) (finding that the transition from subacute to chronic pain is associated with greater involvement of emotion related brain areas during pain).

61. Baliki et al., *supra* note 60, at 149.

62. Hashmi et al., *supra* note 60, at 2766.

63. *See id.* at 2764 (observing that perception of back pain engages distinct brain activations in the emotion and reward circuits in subjects with chronic pain); Baliki et al., *supra* note 60, at 149–60 (demonstrating that acute painful stimuli elicit distinct patterns of nucleus accumbens activity in chronic back pain patients and healthy controls).

64. *See* A. Vania Apkarian, Marwan N. Baliki & Paul Y. Geha, *Toward a Theory of Chronic Pain*, 87 PROGRESS NEUROBIOLOGY 81, 82 (2009) (listing examples of chronic clinical pain conditions related to site and type of injury, such as arthritis, cancer, and diabetes).

65. *Id.* (stating that the common clinical definition of chronic back pain is six months of persistent pain following its initial onset).

the disease, and that effective treatment of the disease will also result in total pain relief.[66]

B. Bases for Individual Pain Variability

Panelists and other participants discussed several sources that explain the great range of individual differences in pain experience and pain reporting.[67] They commented on factors that include the nature of the disease or illness itself, the accuracy and quality of the diagnosis and treatment that the patient receives (with better medical care being strongly predictive of better outcomes), the degree of psychosocial support experienced by the patient, the psychological and phenotypic make-up of the patient, the genetics of pain, and the role of culture on mediating pain experience.[68] Of note, Professor Karen Davis suggested that the neuroimaging of certain mental strategies collectively known as "coping" may be more useful than the neuroimaging of pain itself to evaluate an individual's ability to adapt successfully to pain.[69] Discussion of these many factors was relatively brief, but this discussion serves to point the reader toward relevant bodies of research that help to explain individual pain variability.

As a foundational matter, panelists agreed that the quality of medical care can explain the variation in patient pain and outcome, and that medical mismanagement (such as misdiagnosis or a provider's over reliance on opioids to treat pain) can make a patient's present pain and future prognosis significantly worse.[70] In many cases, such factors could account for why two patients with apparently equivalent injuries or disease states could display significantly different levels of pain and disability.[71]

Where patients receive appropriate diagnosis and medical management, individual variation in levels of pain and disability still may be great. Professors Karen Davis and Jennifer Haythornthwaite contributed to the panel by discussing two factors that may bear significantly on patient

66. An excellent example is orofacial cancer—complete removal of the tumor and borders always results in pain relief. Brian L. Schmidt, *Biological Mechanisms of Oral Cancer Pain and Implications for Clinical Therapy*, 91 J. DENTAL RES. 447, 447–48 (2012).

67. *See, e.g.*, Panel 2, *supra* note 1, at 18 (summarizing bases of variability in pain experience).

68. *Id*. at 18, 22–24.

69. *Id.* at 15.

70. *Id*. at 21.

71. *See generally id.* (discussing the use and efficacy of opiates and antidepressants in the treatment of chronic pain).

outcomes: coping and self efficacy.[72] Professor Davis introduced the issue of coping,[73] and studies that she conducted with David Seminowicz found that "there are different kinds of phenotypes of people," which correlate strongly with how well subjects can cope with pain.[74] According to Professor Davis, some individuals who are subjected in the lab to a painful stimulus ("we're zapping them" in the arm) while performing a cognitively demanding task can compartmentalize or mentally wander away from the pain.[75] With other subjects, "their performance on [the cognitive] tasks goes down—their coping is terrible."[76] Neuroimaging, she asserted, supports the conclusion that these different responses reflect distinct biological phenotypes.[77] Future research would be needed to determine if the same differences would be observed in the context of chronic pain, and to explore the question of adaptability—that is, whether phenotypic differences between "copers" and "non-copers" are stable, or whether non-copers could learn to cope better by modifying their behavior and their biology.[78]

Professor Haythornthwaite raised a related issue—the notion that differences in pain level and outcome for patients with chronic pain (who have otherwise been correctly diagnosed and treated) can be influenced by

72. *Id.* at 17–18 (noting that helplessness and inability to cope are associated with negative outcomes in chronic pain patients, such as higher reports of pain and disability).

73. *Id.* at 15.

74. *Id*. (referencing David A. Seminowicz & Karen D. Davis, *Cortical Responses to Pain in Healthy Individuals Depends on Pain Catastrophizing*, 120 J. PAIN 297, 302 (2006)) (supporting the attentional model of pain catastrophizing, where diminished prefrontal cortical modulation impedes disengaging from and suppressing more intense pain).

75. *Id.*; *see also* Aaron Kucyi, Tim V. Salomons & Karen D. Davis, *Mind Wandering away from Pain Dynamically Engages Antinociceptive and Default Mode Brain Networks*, 110 PROC. NAT'L ACAD. SCI. 18692, 18695 (2013) (describing the relationship between mind wandering and perceptual decoupling from pain).

76. Panel 2, *supra* note 1, at 15.

77. *Id*. Davis stated that there are "different brain circuitries associated with whether [people are] 'copers' or 'not-copers'." *Id.*; *see also* Nathalie Erpelding & Karen D. Davis, *Neural Underpinnings of Behavioural Strategies that Prioritize Either Cognitive Task Performance or Pain*, 154 J. PAIN 2060, 2067 (2013) (distinguishing brain structure, function, and network connectivity patterns of "A-type" individuals who prioritize cognitive performance over pain from "P-type" individuals whose cognitive performance declines when experiencing concurrent pain); Kucyi, Salomons & Davis, *supra* note 75 (linking individual tendencies to "mind wander" away from pain with the function and structure of pain- and attention-related brain networks).

78. Panel 2, *supra* note 1, at 15. If future studies were to establish the existence of coping and non-coping phenotypes in response to chronic pain, Professor Davis suggested that the neuroimaging of coping—rather than of pain itself—might have significant evidentiary value. *Id.* She opined that "this issue of how much your brain circuitry is set up to cope with pain . . . might actually lead us in a better direction[] [b]ecause those things seem to be more stable and phenotypic than just seeing what lights up in your brain when you give somebody a stimulus." *Id.* Imaging of this kind, she suggested, might tell us more about "individual variability" in response to dealing with pain. *Id.*; *see also* Erpelding & Davis, *supra* note 77, at 2060 (explaining that studies on brain functions between copers and non-copers reveal that potential behavioral changes may be made in non-copers to alleviate their pain and their ability to cope with their pain).

the patient's level of self-efficacy[79] versus helplessness.[80] People who measure low on self-efficacy may be described as feeling "helpless . . . in the face of difficult circumstances.[81] Professor Haythornthwaite noted that feelings of "helplessness [are] associated with increased morbidity and mortality in people with rheumatoid arthritis. And, in people with chronic pain, helplessness is associated with higher reports of pain, greater pain related disability, higher levels of depression," and other negative outcomes.[82] Professor Haythornthwaite's research focuses on patients' subjective self perceptions of helplessness as related to pain intensity and disability.[83] She noted that her research has also shown that negative coping strategies, collectively called "catastrophizing," correlate with increased reports of pain and greater levels of future disability.[84] Research on

79. Panel 2, *supra* note 1, at 17; *see also* Timothy A. Judge et al., *Are Measures of Self-Esteem, Neuroticism, Locus of Control, and Generalized Self-Efficacy Indicators of a Common Core Construct?,* 83 J. PERSONALITY & SOC. PSYCHOL. 693, 693 (2002) (explaining that self efficacy shares features with other psychological constructs, including the constructs of control and neuroticism, demonstrating that these several constructs represent the same mental phenomena and are not meaningfully distinct); Barry J. Zimmerman, *Self-Efficacy: An Essential Motive to Learn*, 25 CONTEMP. EDUC. PSYCHOL. 82, 83 (2000) (noting that self efficacy is a psychological construct that refers to a subject's degree of perceived control or agency over the events in his or her life).

80. Panel 2, *supra* note 1, at 17.

81. *See* Matthias J. Müller, *Helplessness and Perceived Pain Intensity: Relations to Cortisol Concentrations After Electrocutaneous Stimulation in Healthy Young Men*, BIOPSYCHOSOCIAL MED., June 2011, at 1, 1–2, *available at* http://www.bpsmedicine.com/content/pdf/1751-0759-5-8.pdf (noting that there is a correlation between patients that have low self efficacy and feelings of helplessness in difficult scenarios).

82. Panel 2, *supra* note 1, at 17. *See generally* R.R. Edwards et al., *Catastrophizing and Pain in Arthritis, Fibromyalgia, and Other Rheumatic Diseases*, 55 ARTHRITIS & RHEUMATISM 325 (2006) [hereinafter *Pain in Arthritis*] (explaining that pain is increasingly seen in patients who suffer from rheumatic disease, which can result in the patient catastrophizing the pain and feeling helpless); R.R. Edwards et al., *Catastrophizing Predicts Changes in Thermal Pain Responses After Resolution of Acute Dental Pain*, 5 J. PAIN 164 (2004) [hereinafter *Catastrophizing Predicts Change*] (noting that patients who suffer from chronic pain have higher levels of helplessness, disability, and depression as a result of catastrophizing their pain).

83. *See generally Catastrophizing Predicts Change*, *supra* note 82, at 164 (explaining that patients who suffer from catastrophizing their chronic pain share feelings of helplessness and disability); *2012 Wilbert E. Fordyce Clinical Investigator Award*, AM. PAIN SOC'Y, http://americanpainsociety.org/get-involved/awards-grants/wilbert-e-fordyce-2012 (last visited Jan. 25, 2015) (stating that Professor Haythornthwaite has researched psychosocial aspects of pain, with a focus on how negative emotions and pain coping strategies affect pain and pain related disability).

84. Panel 2, *supra* note 1, at 17–18; *see also* L. Buenaver et al., *Cognitive-Behavioral Self-Help for Chronic Pain*, 62 J. CLINICAL PSYCHOL. 1389, 1389–90 (2006) (noting that cognitive-behavioral self help is one of the most effective ways of dealing with patient pain catastrophizing); *Pain in Arthritis*, *supra* note 82, at 325–28 (explaining that patients who catastrophize their pain report greater pain and disability); R.R. Edwards et al., *Catastrophizing as a Mediator of Sex Differences in Pain: Differential Effects for Daily Pain Versus Laboratory-Induced Pain*, 111 J. INT'L ASS'N STUDY PAIN 335, 335–36 (2004) (noting that how an individual deals with their pain will affect their pain levels and disability); *Catastrophizing Predicts Change*, *supra* note 82, at

helplessness and control provides another dimension in understanding how two subjects with substantially similar diagnoses could experience very different degrees of pain and disability.[85]

Speaking on both the genetics of pain and the role of culture on influencing pain experience, Professor Davis noted that Dr. Ze'ev Seltzer had attempted to study the prevalence and severity of phantom limb pain in Cambodia, a country with many landmine victims.[86] The aim of this study was to assess the relative prevalence and severity of phantom limb pain relative to population level averages in Western amputees.[87] Professor Davis reported, however, that Dr. Seltzer ran into a conundrum that demonstrates the difficulty of translating pain experience across cultures: the Western language of "phantom" limb pain could not be translated linguistically or culturally into the Cambodian context.[88] The researchers inadvertently biased the study subjects by suggesting to them that the study subjects' missing limbs and/or persons were demonically possessed.[89]

Holding aside challenges of cultural translation like those experienced by Dr. Seltzer, Professor Davis noted that researchers may be likely to find both individual and population level variation in pain sensitivity. Some of this variability may be genetic. Further, culturally mediated constructs relating to pain, self, and the experience of the body also likely would lead to cross cultural variations not only in the expression of pain but also in the actual experience of pain. A growing body of research literature suggests these dynamics to be the case, finding some variation in pain sensitivity based on genetic, epigenetic, and cultural factors.[90]

164–65 (noting that catastrophizing pain typically results in greater pain and feelings of pessimism).

85. *See* Müller, *supra* note 81, at 1–4 (noting that recent laboratory studies have shown that enforced helplessness increases pain sensitivity). Where young, healthy male research subjects were allowed either to give themselves an electric shock or were subjected to an equal strength electric shock out of their control, they reported significantly more pain in the no control or "helpless" condition. *Id.* Researchers found that in the helpless condition, subjects produced more of the stress hormone cortisol, which itself can heighten pain experience. *Id.* Individuals with chronic pain could vary both on their psychological evaluation of their situation and the extent to which, like the lab subjects, pain occurs without any control on the part of the subject; both could heighten cortisol and, hence, pain experience. *Id.*

86. Panel 2, *supra* note 1, at 23; *see also* Mervyn Rothstein, *Columnist Mervyn Rothstein Interviews Dr. Ze'ev Seltzer*, THE FACIAL PAIN RESEARCH FOUND., http://www.facingfacialpain.org/index.php?option=com_content&view=article&id=181&Itemid=137 (last visited Mar. 16, 2015) (noting that research has been collected from 6,000 amputees in Cambodia to analyze chronic pain).

87. Rothstein, *supra* note 86.

88. Panel 2, *supra* note 1, at 23.

89. *Id.*

90. *See, e.g.*, Kathy Lasch et al., *Psychological and Cultural Influences on Pain and Recovery from Landmine Injury*, 7 PAIN MED. S213, S213–15 (2006) (noting that various cultural factors such as the amputee's societal acceptance can have negative effects on the amputee). Cultural

It is worth noting that some research also points in the other direction, finding no meaningful difference in average pain experience across very different populations.[91] A recent study found no difference in the prevalence and severity of phantom limb and stump pain in amputees in New Zealand versus in Cambodia.[92] Some researchers exploring the hypothesis that the traumatic context of an injury leads to outcomes with a higher likelihood of chronic pain have also reached a negative result.[93] Panelists were also mindful of the history of stereotyping groups relative to pain sensitivity, and the role that stereotypes can play in the disparity of effective pain treatment.[94]

C. Evaluating Pain Sensitivity

1. Pain rating scales and tools

> [E]ven those of us who make a living out of evaluating pain sensitivity in people and rely on these numbers to tell us something . . . make certain assumptions that [don't hold up, even] in a pristine laboratory setting, [and] . . . in kind of real world situations . . . they're [even more] questionable [where a person may have an incentive to be untruthful].
>
> *Prof. Joel Greenspan*[95]

factors like the isolation and shunning of amputees can have devastating effects on survivors and their long term outcomes. *See* Bridgett Rahim-Williams et al., *A Quantitative Review on Ethnic Group Difference in Experimental Pain Response: Do Biology, Psychology and Culture Matter?* 13 PAIN MED. 522, 535–37 (2012) (examining and confirming various studies determining that an individual's biology, psychology, and culture impact their pain).

91. *See, e.g.*, Kelly Patrick Anthony Byrne, *Survey of Phantom Limb Pain, Phantom Sensation and Stump Pain in Cambodian and New Zealand Amputees*, 12 PAIN MED. 794, 795 (2011) (finding, in a study of limb pain in different ethnic cultures, that there was no substantial difference in the cultures' pain experience).

92. *See id.* (noting that researchers could not find substantial differences in how different cultures respond to similar phantom limb pain scenarios).

93. *See* Hans Husum et al., *Chronic Pain in Land Mine Accident Survivors in Cambodia and Kurdistan*, 55 SOC. SCI. & MED. 1813, 1813–16 (2002) (assessing a study on the differences in various cultures and how their personal background affects their pain and pain related problems).

94. *See* Panel 2, *supra* note 1, at 22–23. A recent study in the U.S. found that black and hispanic patients tend to receive significantly less pain control medication than white male patients following identical surgical procedures. *See* H. Jack Geiger, *Racial and Ethnic Disparities in Diagnosis and Treatment: A Review of the Evidence and a Consideration of Causes*, *in* UNEQUAL TREATMENT, CONFRONTING RACIAL AND ETHNIC DISPARITIES IN HEALTH CARE 417, 425 (Brian D. Smedley, Adrienne Y. Stith & Alan R. Nelson, eds., 2003). Such disparities may be grounded in providers' implicit assumptions that the non white patients' reports of pain are exaggerated or reflect drug seeking behavior. *Id.*

95. Panel 2, *supra* note 1, at 4.

Pain evaluation techniques are designed to help determine how much pain a patient experiences and to allow for the benchmarking of a patient's pain relative to other patients with substantially similar histories and conditions.[96] Professor Greenspan discussed the most common pain evaluation technique, in which a patient is asked to rate his or her pain on a scale from zero to ten, with zero being no pain and ten being the worst pain imaginable.[97] Panelists then engaged in a discussion of the pain rating scale and various issues relating to pain reporting and evaluation.[98] The themes and issues that emerged from this discussion included the imprecision of existing pain rating scales, the degree of subjective variation (both in how people experience pain and in how they report and communicate their pain), and, finally, the important variation in how parties consuming the information (like doctors and legal actors) hear and interpret pain reports.[99]

Because pain is a personal experience, the gold standard for pain measurement is self reporting.[100] In clinical and research settings, pain is often evaluated on a 10 point numerical rating scale, where 0 is no pain and 10 is the worst pain imaginable.[101] Other pain measures, including the McGill Pain Questionnaire,[102] are commonly used to determine the sensory and affective qualities of the pain.[103] Professor Greenspan noted that you have to assume in this kind of situation is that one patient's "three" is the same as another patient's "three," and that everybody who says "three" is reflecting a similar perceptual level of pain and distress."[104] But this is merely a simplifying assumption that clinicians make "for the sake of doing

96. *See* Maria Alexandra Ferreira-Valente et al., *Validity of Four Pain Intensity Rating Scales*, 152 PAIN MED. 2399, 2399–402 (2011) (explaining the different pain evaluation techniques and their various merits).

97. Panel 2, *supra* note 1, at 2; *see also* NAT'L PHARM. COUNCIL, PAIN: CURRENT UNDERSTANDING OF ASSESSMENT, MANAGEMENT, AND TREATMENTS 25 (2001), *available at* http://www.npcnow.org/system/files/research/download/Pain-Current-Understanding-of-Assessment-Management-and-Treatments.pdf (noting that this zero to ten scale rating is referred to as the Numerical Rating Scale ("NRS")).

98. Panel 2, *supra* note 1, at 6–7.

99. *Id.* at 2–6.

100. *See* NAT'L PHARM. COUNCIL, *supra* note 97, at 21 (noting that a patient's ability to express their pain is the preferred method of pain diagnosis since pain is subjective).

101. *See* Ferreira-Valente et al., *supra* note 96, at 2399–400 (noting that the NRS has been demonstrated to be accurate and user friendly to patients).

102. *See* Ronald Melzack, *The McGill Pain Questionnaire: Major Properties and Scoring Methods*, 1 J. PAIN 277, 277 (1975) (explaining that the McGill Pain Questionnaire consists of 3 classes of pain descriptors used by patients to specify their pain).

103. *Id.*

104. *See* Panel 2, *supra* note 1, at 4; *see also* Ferreira-Valente et al., *supra* note 96, at 2399 (explaining that pain research studies have demonstrated that different pain measures yield comparable results, demonstrating their efficacy and reliability for different levels of pain).

anything practical in a clinical setting."[105] Apart from the practical value of the assumption, "we have no way of knowing if that's true or not."[106] To help physicians or others corroborate the patient's rating of pain (or, vice versa, to call it into question), clinicians also look at "other kinds of evidence, behavior, facial expressions, things like that."[107] But this is not a precise practice, as there is no "formula for that."[108]

Professor Adam Kolber noted that a central challenge in using and making sense of the pain rating scale is that it instructs patients to rate their pain from zero to ten, where ten is "the worst pain imaginable." This makes the rating scale "as much a test about imagination as it is about pain."[109] A person who has "a very vivid imagination about the worst pain that there could be" would rate his pain as less severe, while a person with a duller imagination might rate his equal degree of pain as being more severe, even though both patients are experiencing the same degree of pain, distress, and disability.[110] Professor Kolber commented that he could rate his pain of a sprained elbow at a "1" simply because he could imagine the horrors of the Inquisition, but Professor Kolber's elbow does not hurt more or less than if his benchmark for the worst pain imaginable is the time he had a toothache.[111]

For clinicians assessing patients, each patient's individualized and subjective use of the rating scale may not present a great problem: the clinician's role is to understand that particular patient's perceived level of pain and distress, and to treat the pain appropriately.[112] The individualized meaning of pain ratings, however, becomes highly important in comparing

105. Panel 2, *supra* note 1, at 4; *see also* Melzack, *supra* note 102, at 278 (noting that there are severe limitations with the pain questionnaire due to the complexity of variable pain).

106. Panel 2, *supra* note 1, at 4; *see also* Melzack, *supra* note 102, at 278 (explaining that pain is a subjective experience, so it is hard to quantify a person's perceptual level of pain).

107. Panel 2, *supra* note 1, at 4; *see also* Melzack, *supra* note 102, at 278–79 (explaining that the researchers not only took into account the subjects' descriptions of pain, but also accounted for their different cultural, socio-economic, and educational backgrounds when assessing their pain levels). Such questions include "what activities is this person still doing?" and "what is he or she avoiding?" But this is not a precise practice, as there is no "formula for that." Panel 2, *supra* note 1, at 4.

108. Panel 2, *supra* note 1, at 4.

109. *Id.* at 6; *see also* Amelia Williamson & Barbara Hoggart, *Pain: A Review of Three Commonly Used Pain Rating Scales*, 14 J. CLINICAL NURSING 798, 800–01 (2004) (describing various numerical pain rating scales, ranging from a 10 point scale to 101 point scales).

110. Panel 2, *supra* note 1, at 6; *see also* Williamson & Hoggart, *supra* note 109, at 799 (describing the subjective nature of pain and the typical 'no pain' to 'worst pain imaginable' descriptors on pain scales).

111. Panel 2, *supra* note 1, at 6.

112. *See* NANCY WELLS ET AL., 1 PATIENT SAFETY AND QUALITY: AN EVIDENCE-BASED HANDBOOK FOR NURSES ch. 17, at 472–73, 476 (2008) (emphasizing that documentation of pain assessment is necessary so the clinician can best interpret the patient's pain and the appropriate care plan).

pain across patients and across populations of patients.[113] If pain ratings on the zero to ten scale are incommensurate across patients, reflecting not only the subject's physical experience but psychological and even imaginative make up, it becomes challenging to say that a particular injury or condition typically hurts at about a "three," because any reported "three" has meaning relative to the person providing the rating, and it is not relative to some absolute level of pain sensation that would allow researchers to establish an average or typical level of pain for a particular condition.[114]

2. Neuroimaging corroborates variation in pain reporting for acute, lab induced pain

In addition to informing us which brain areas are activated during the experience of pain, pain neuroimaging studies have also provided a neurological basis for individual differences in pain sensitivity and coping.[115] For example, Professor Greenspan referred to "the classic first demonstration of this type of phenomena, [which] came from Bob Coghill's paper that was in [the Proceedings of the National Academy of Sciences]"[116] that showed the relationship between pain neuroimaging and the subjective report.[117] In that study, healthy participants were exposed to a thermal stimulus in the MRI scanner.[118] The temperature was the same for all participants, but the pain intensity ratings varied greatly, spanning almost the entire 0 to 10 scale.[119] Coghill then divided participants into two groups: a high sensitivity group (those who rated pain above a 6 out of 10) and a low sensitivity group (those who rated pain below a 4 out of 10).[120] Comparing brain activity between these two groups, the high sensitivity

113. *See* Melzack, *supra* note 102, at 282 (describing a study conducted with 297 diverse patients, each suffering from different kinds of pain); Stefaan Van Damme, *A Confirmatory Factor Analysis of the Pain Catastrophizing Scale: Invariant Factor Structure Across Clinical and Non-Clinical Populations*, 96 J. PAIN 319, 319–320 (2001) (explaining the benefit of examining the pain catastrophizing scale over a wide variety of patients with and without pain, and across clinical and non-clinical populations).

114. Panel 2, *supra* note 1, at 4. *See also* Henry K. Beecher, *The Measurement of Pain: Prototype for the Quantitative Study of Subjective Responses*, 9 PHARMACOLOGICAL REVS. 59, 62–64 (1957) (emphasizing that pain is a subjective perception that varies from person to person and is resultantly difficult to operationally define and test).

115. *See* Robert C. Coghill et al., *Neural Correlates of Interindividual Differences in the Subjective Experience of Pain*, 100 PROC. NAT'L ACAD. SCI. 8538, 8538–42 (2003) (explaining a functional MRI neuroimaging study of inter-individual differences in pain sensitivity).

116. Panel 2, *supra* note 1, at 14. *See* Coghill et al., *supra* note 115.

117. Panel 2, *supra* note 1, at 14. *See* Coghill et al., *supra* note 115, at 8538 (explaining the effective use of brain imaging tests in conjunction with subjective pain reports).

118. Coghill et al., *supra* note 115, at 8538.

119. *Id.* at 8538–40.

120. *Id.* at 8539.

group had greater activity in the primary somatosensory cortex and mid cingulate cortex—areas that are thought to encode pain intensity and the emotional salience of pain.[121] The activity level in the thalamus, however, did not differ between groups, suggesting that the nociceptive input to the brain was identical, and that the difference in experience must be related to the difference in cortical activation.[122]

Several pain neuroimaging research groups have found similar results. Professor Davis noted that "[many] of us who were monkeying around in the noise found similar things, and we didn't talk about it for a couple of years. We found this correlation between the amount of pain they say they reported and the amount [that the] fMRI signal [detected]."[123] In addition, a number of studies have reported on brain areas whose activity correlates with pain intensity.[124]

Another example of neuroimaging corroborating with the individual experience is a study that examined the relationship between pain catastrophizing and pain related activity.[125] In that study, participants experienced pain while in the MRI scanner, but the pain intensity was set to be the same for everyone.[126] Despite experiencing the same pain intensity, subjects who scored high on pain catastrophizing showed increased activity in several regions of the insula cortex—an area thought to be involved in emotional processing.[127] This enhanced brain activity in emotional regions could reflect the fact that pain catastrophizing is associated with the fear that pain will become more serious and will not end.[128] Similar associations

121. *Id.* at 8538, 8541.

122. *Id.* at 8541.

123. Panel 2, *supra* note 1, at 14.

124. *See, e.g.*, M.N. Baliki, et al., *Parsing Pain Perception Between Nociceptive Representation and Magnitude Estimation*, 101 J. NEUROSCIENCE 875 (2009) (concluding that pain perception is a result of the transformation of nociceptive representation into a subjective magnitude assessment within the insula); K. Bornhovd et al., *Painful Stimuli Evoke Different Stimulus-Response Functions in the Amygdala, Prefrontal, Insula and Somatosensory Cortex: A Single-Trial fMRI Study*, 125 J. NEUROSCIENCE 1326 (2002) (finding that brain responses evoked by four different pain stimuli intensities ranged from warm to painful); Yoshitestsu Oshiro et al., *Brain Mechanisms Supporting Discrimination of Sensory Features of Pain: A New Model*, 29 J. NEUROSCIENCE 14924, 14928 (2009) (finding that memory activation in the brain correlated with pain intensity activation).

125. *See* Seminowicz & Davis, *supra* note 74 (discussing a study in which a fMRI was performed on 22 healthy individuals while they underwent two pain intensity levels in order to understand the psychological pain catastrophizing factors associated with each person's experience of pain).

126. *Id.* at 298.

127. *Id.* at 300–01.

128. *See* Judith Turner & Leslie Aaron, *Pain-Related Catastrophizing: What Is It?*, 71 CLINICAL J. PAIN 65, 65–66 (2001) (describing catastrophizing as dwelling on the worst possible outcome of a particular circumstance when there is any possibility this outcome could ensue).

between pain catastrophizing and pain related brain activity have been reported in chronic pain patients.[129]

Knowing that neuroimaging data corroborates subjective pain experience could be useful in the legal system. One is still faced with the limitation, however, that these findings are based on an average across a group. Further, it still brings us to a "reverse inference problem:"[130] "[in] any one case, if we see this level of activation, do we know that that person's really experiencing a level of pain that matches the average picture?"[131] Professor Davis also mentioned a limitation related to the specificity of the neuroimaging signals in brain areas that are involved in multiple cognitive functions: "If you're feeling more pain, you're probably paying more attention to it, and it's probably more unpleasant, and it's probably more upsetting. And if you're looking at a place in the brain like the cingulate cortex, which everything happens in the cingulate cortex . . . we can't separate these things."[132]

Despite these pitfalls, neuroimaging generally supports the theory that the subjective experience should be promising and useful in legal settings, as it would suggest a neurobiological basis for pain sensitivity and coping. While claims of pain might, in some cases, seem unrealistic, it is clear from both neuroimaging and psychophysics studies that there exists great variability in pain expression, even amongst healthy, pain free people.

129. *See* R. H. Gracely, *Pain Catastrophizing and Neural Responses to Pain Among Persons with Fibromyalgia*, 127 BRAIN 835, 836 (2004) (explaining that psychosocial factors relating to pain catastrophizing may play a significant role in patients with chronic pain).

130. Panel 2, *supra* note 1, at 14. *See* L. Van Oudenhove, *Understanding Gut-Brain Interaction in Gastrointestinal Pain by Neuroimaging: Lessons from Somatic Pain Studies*, 23 NEUROGRASTROENTEROLOGY & MOTILITY 292, 299 (2011) (explaining that reverse inference refers to "reasoning backwards from the presence of activation of a certain region known to be involved in a particular cognitive function"). Reverse inference is also discussed in more detail in Panel 4. Dr. Martha Farah, PhD, Judge Nancy Gertner, & Prof. Stacey Tovino, Imaging the Brain, Changing Minds: Chronic Pain Neuroimaging and the Law Symposium, Panel 4: Translational Expectations and Issues: Making it Work in Practice (Apr. 25, 2014) [hereinafter Panel 4] (transcript on file with the editors).

131. Panel 2, *supra* note 1, at 14.

132. *Id.*; *see also* Alexander Shackman et al., *The Integration of Negative Affect, Pain and Cognitive Control in the Cingulate Cortex*, 12 NAT'L REV. NEUROSCIENCE 154 (2011) (describing the cingulate cortex as one of the most prominent features of the brain).

III. LEGAL AND POLICY CONSIDERATIONS CONCERNING BRAIN BASED PAIN

A. Pain Interpretation by Judges and Jurors

The Honorable Morris Hoffman, a frequent commentator on law and neuroscience and a founding member of the MacArthur Law & Neuroscience Project, spoke on the ways in which legal doctrines and legal actors struggle with issues relating to pain.[133] He introduced several key themes: the variability of pain itself combined with the variability that decision makers (like judges and jurors) have in being able to understand the pain of others; the composite nature of pain as both a physical phenomenon and a narrative experience that has meaning within the context of an individual's life; and the difficulties of "mind-reading," which are present in relation to many legal determinations, but which may be particularly acute in relation to pain and suffering.[134] Judge Hoffman's comments appear here largely in their original form:

> I'm interested in, and I think the law's interested in pain [and the] problems that pain raises for two related reasons . . . : It's everywhere [and] everybody's already talked about this, [and pain] is everywhere in the law. . . I think [this] is one of [the] few areas of the law that the law might not be very good at.[135]

> [Professor Hank Greely] spoke eloquently[136] about how humans are mind-reading machines. Many legal processes turn on a kind of mind-reading. We care very much in legal processes about this always difficult process of reading other peoples' minds. Different people may have different fears when confronted with someone with a gun, or who might look like he has a gun: some of us might have fears great enough to justify self defense, some of us might not, and as judges and jurors, we need to get into the mind of

133. Panel 2, *supra* note 1, at 9.

134. *Id.* at 9–11.

135. *Id*. at 9; *see generally* Eric A. Posner, *Law and the Emotions*, 89 GEO. L.J. 1977 (2001) (stating that the role of emotions in the law has been "much neglected" and that legal theory is "unprepared" to discuss the relationship between emotions and the law).

136. Panel 2, *supra* note 1, at 9. Prof. Greely spoke about mind-reading in the law and using fMRI as a potential mind-reading technology in his keynote address that opened the conference. *Id.*

> the person claiming self defense to figure out which is the case. So the law really struggles with that. All of these emotions and mental states that the law cares about are subjective and variable.
>
> But pain seems especially difficult.
>
> . . .
>
> I think there's something about pain that is harder than these other emotions to deal with in law. And I can think of three reasons why that might be.
>
> First, pain is enormously variable, perhaps more than other emotions. Not just between people but within people. . . . the same stimulus can have enormously different effects within people.
>
> [Second,] I'm starting to think that pain is really complicated. [*Laughter in the room.*] There's a narrative . . . aspect to pain [and to the role that the pain plays in an individual's life that may affect how a person experiences pain and how much it impairs him or her].[137]
>
> [Third,] . . . the law is really good at operationalizing human nature and having rules based on thousands of years of trial and error, [but] there are a couple of areas that I worry about, where we're not so good at—pain . . . [and] probability. . . humans just are not good at probability, and therefore the law is not very good at probability. . . . And I worry that one of the things the law's not good at, because humans are not good at [it] is empathizing [with] certain kinds of pain—chronic pain. . . . [F]or some reason, I think most people don't believe in chronic pain.[138]

137. *Id*. at 9–10. *See generally* Coghill, *supra* note 16, at 1531–35 ("The experience of a sensory event is highly subjective and can vary substantially from one individual to the next."); Robert C. Coghill et al., *The Subjective Experience of Pain: Where Expectations Become Reality*, 102 PROC. NAT'L ACAD. SCI. 12950, 12950 (2005) (noting that the subjective experience of pain has long remained a perplexing and challenging clinical problem).

138. Panel 2, *supra* note 1, at 10. For further discussion on the empathy of people to the pain of others, see Phillip L. Jackson, Pierre Rainville & Jean Decety, *To What Extent Do We Share the Pain of Others? Insight from the Neural Bases of Pain Empathy*, 125 J. PAIN 5, 8 (2006) (studying the neurological impacts of pain inflicted upon one's self versus pain inflicted against others).

Judge Hoffman then elaborated on each of these three points. On the question of the variability of pain, he commented briefly that most people, including himself, share the intuition that a person would be more severely injured by an objectively severe accident—say, a car crash that occurs at 30 miles per hour versus a crash at 10 miles per hour.[139] Statistically, that generally will be true.[140] Yet, he noted, that may not be the outcome in any individual case, as a myriad of factors peculiar to the accident itself and to the person involved in the accident could cause the victim in the low speed crash to experience more pain and disability than the person in higher speed crash.[141] Jurors and judges have a hard time grappling with the cases that are both unusual and counterintuitive.[142] It is easier, instead, to rely on more objective measures of severity (the damage to the car or the presence of broken bones) as the benchmark for how much pain a claimant likely feels or felt.[143] Judges and jurors may be particularly inclined to doubt plaintiffs who raise these unusual or counterintuitive pain claims because of the prospect of financial gain from lawsuits.[144] In this way, doubt about the subjective and variable nature of pain, particularly pain that results from outwardly minor injuries, acts to some extent as an anti fraud device, though this "device" produces both false positives and false negatives.[145]

The key form of variability that Judge Hoffman focused on, however, is the variability among decision makers in being able to understand the pain of others.[146] He described a case that he presided over a decade ago:

> I remember a sort of gruesome products liability case . . . and it involved a woman who was using a cleaning product that had a small warning [on the bottle that stated:] "use

139. Panel 2, *supra* note 1, at 11.

140. *See generally Table 1108. Speeding-Related Traffic Fatalities by Road Type, Speed Limit, and State: 2009*, U.S. CENSUS BUREAU (2012), http://www.census.gov/compendia/statab/2012/tables/12s1108.pdf (indicating that in interstate travel, 964 fatalities occurred in accidents where the vehicle was traveling over 55 miles per hour compared to 287 fatalities where the vehicle was traveling at below 55 miles per hour).

141. Panel 2, *supra* note 1, at 11; *see also* Jeffery Tucker, *Injury with Low-Speed Collisions*, DYNAMIC CHIROPRACTIC, May 22, 1995, http://www.dynamicchiropractic.com/mpacms/dc/article.php?id=40251 (outlining factors that may influence injuries suffered in low speed car crashes).

142. Panel 2, *supra* note 1, at 11.

143. *Id.*

144. *See id*. at 10 (noting that it is hard for people to believe when plaintiffs experience certain types of chronic pain).

145. *Id*. at 10–11.

146. *Id*. at 9–10; *see also* Eric A. Posner, *Law and the Emotions* 20 (Univ. of Chi. Law Sch., John M. Olin Law & Economics Working Paper No. 103, 2000) (discussing the variability of juries, the role of jury emotions in their decision making, and the possibility that jury emotions do not improve their ability to measure pain and suffering of others).

> rubber gloves with this product." She used it without rubber gloves, and then got terrible, terrible, terrible burns on her hands.[147]

As a result, the woman had multiple surgeries to repair the skin on her hands and still had ongoing pain.[148] Judge Hoffman noted that the plaintiff had claims for medical damages and also for "enormous amounts [in damages] for pain and suffering."[149] What struck Judge Hoffman was the way in which the plaintiff's attorney questioned potential members of the jury during jury selection.[150] For the plaintiff and her attorney, he noted, the key issue was determining which jurors are going to be able to imagine that kind of pain. Some people are going to be able to imagine that and some people are not.[151] Accordingly, the attorney had to determine through skillful questioning which potential jurors might be able to imaginatively project themselves into the victim's position and understand what it feels like to have the pain that she claimed she had, and which jurors may even have had hand injuries themselves which would make them more aware of the degree of the impairment.[152] Just as people vary in their pain sensitivity, Judge Hoffman commented, people also vary in their ability to feel or believe in the pain of others as well as how a person ought to cope with pain depending on the persons norms and values.[153] This adds potential uncontrolled variability across cases, which may or may not be fair to the parties, and that to some extent, is intrinsic in the jury system itself.[154]

Moving on to the issue of how we think about or conceptualize the experience of pain, Judge Hoffman analogized pain to another biological yet subjective and legally important phenomenon—memory. He commented that

147. Panel 2, *supra* note 1, at 9. Judge Hoffman explained that the legal issue in the case related to whether the small warning on the bottle was adequate in light of the risk of harm posed by the product. *Id.* For the complete opinion of the case discussed by Judge Hoffman, see Uptain v. Huntington Lab, Inc., 723 P.2d 1322 (Colo. 1986).

148. Panel 2, *supra* note 1, at 9; *see also Uptain*, 723 P.2d at 1324.

149. Panel 2, *supra* note 1, at 9.

150. *Id.* at 9–10.

151. *Id.* at 9–10 (explaining that the attorney utilized the example of pulling a sliver from one's finger to determine which jurors seemed to perceive the idea of pain more than others).

152. *Id.* at 10.

153. *Id.* at 9–10; *see generally* Phillip L. Jackson, Andrew N. Meltzoff & Jean Decety, *How do we Perceive the Pain of Others? A Window into the Neural Processes Involved in Empathy*, 24 NEUROIMAGE 771, 771 (2005) (finding that there is "partial cerebral commonality between perceiving pain in another individual and experiencing it oneself").

154. Panel 2, *supra* note 1, at 11.

> there was a time when we thought memory was like a tape recorder. That time roughly matches the time when tape recorders were invented. And then when computers were invented . . . the models changed to talk about things like "working memory" and these sorts of things . . . [and] it's becoming clear with memory that it's not exactly like any of [these technologies]. . . . [T]here's a narrative aspect [to memory that's quite different from what a tape recorder or a computer does]—it's constantly consolidating, it's constantly changing, [and] what we think about affects our memory [and] how we think about it affects our memory . . . it seems to me that this may very well be true about pain as well.
>
> And of course in court we're often talking about a mixture of pain and memory, so when [parties] testify about their current or their past pain, that's this conflation of this memory about pain . . . .[155]

Judge Hoffman's perspective on the biographical aspects in experiencing pain and the relationship between pain and memory point in a somewhat different direction than statements by other conference participants about the possible quantification of pain.[156] Part of the variable nature of the experience of pain, he suggests, is that we bring ourselves to it.[157] Prior panelists commented that one person's "three" on the pain scale may not be equivalent to another person's "three" based on factors that range from genetics to culture to degree of imagination.[158] Judge Hoffman's comments suggest that two raters' evaluations of pain, as well as the pain that two raters might experience in response to the same or similar condition, might also vary because of their individual life histories, personalities, and ways of making meaning.

In his final point, Judge Hoffman explored whether the legal system itself is simply ill suited to certain kinds of determinations, such as determinations about certain kinds of pain that are based on predictable and

155. *Id.*

156. *Compare id.* at 3–4 (reporting that Dr. Greenspan discussed the difficulty of examining and quantifying feelings of pain across large sample populations), *with supra* text accompanying note 153.

157. Panel 2, *supra* note 1, at 9; see *also* Margaret C. Rodgers, *Subjective Pain Testimony In Disability Determination Proceedings: Can Pain Alone Be Disabling?*, 28 CAL. W. L. REV. 173, 173 (1992) (explaining that every person experiences pain differently).

158. Panel 2, *supra* note 1, at 4.

common flaws in human reasoning.[159] He noted that "humans just are not good at probability, and therefore the law is not very good at probability. [But u]nfortunately, probability is everywhere in the law."[160] Similarly, he remarked that humans are not very good at multi-factor causal reasoning.[161] Yet, causation is a crucial legal concept; the outcomes of many cases turn on determinations about the relative importance of various causes to an ultimate outcome. "I worry," he said, "that one of the things the law's not good at, because humans are not good at [it], is empathizing certain kinds of pain, [particularly] chronic pain."[162] Judge Hoffman went so far as to assert that he worries that "most people don't believe in chronic pain. It's hard to believe that [this hand, which looks fine, and maybe works fine,] . . . still hurts. It's hard for people to believe that when the stimulus is gone, the pain is still there."[163] Additionally, he opined that judges may be no better than jurors in that regard—indeed, they "may be worse," because their work somewhat inures them to suffering.[164]

Judge Hoffman commented that in his role as a law professor, he noticed that students seem to have a much easier time crediting pain that is associated with a visible injury or a visible disease process, like phantom limb pain or degenerative arthritic pain.[165] Judge Hoffman noticed that when he teaches students about phantom limb pain, the students seem more understanding and they don't have any problem with it the way that they do with other kinds of chronic pain.[166] Judge Hoffman wonders if it is because the injury is visible or if maybe it has to do with sympathy for someone—they've lost the leg so we'll believe they're also hurting a little bit where the leg isn't there.[167] Other kinds of chronic pain that people don't seem to have problems with include arthritic pain and some clearly degenerative kinds of chronic pain.[168]

In contrast to pain that relates to missing limbs or to degenerative processes that jurors can see on an x-ray, Judge Hoffman asserted that most

159. *Id.* at 10; *see generally* Lynne N. Henderson, *Legality and Empathy*, 85 MICH. L. REV. 1574, 1574–76 (1987) (explaining the struggle the law has with the notion of empathy).

160. Panel 2, *supra* note 1, at 10.

161. *See id.* (explaining that it is difficult for people to accept that pain exists where there is no physical stimulus present); *see also* Jody Lynne Madeira, *Recognizing Odysseus' Scar: Reconceptualizing Pain and Its Empathetic Role in Civil Adjudication*, 34 FLA. ST. U. L. REV. 41, 48 (2006) (explaining that people may be uncertain when the perceived pain does not accompany the physical stimulus).

162. Panel 2, *supra* note 1, at 10.

163. *Id.*

164. *Id.* at 11.

165. *Id.*

166. *Id.*

167. *Id.*

168. *Id.*

people have difficulty believing in the reality of chronic pain.[169] He observed that

> the kind of pain that starts off with a physical stimulus, and [where] the physical stimulus is removed and the pain is still there, jurors just have real problems with that . . . . the good news is that gets rid of the fakers . . . . But the bad news is that . . . because of this built in skepticism about chronic pain, I think jurors are, in general, undervaluing these cases because they just don't believe these plaintiffs, which is a terrible thing.[170]

Judge Hoffman concluded with his hope that neuroimaging and other pain sciences could help jurors understand the reality of chronic pain conditions or that it could help with more direct ways of establishing the presence of pain. "It doesn't have to be perfect," he said.[171] "All it has to be is marginally better than what we have now, which is [almost] nothing."[172]

B. Evidentiary Considerations and Frameworks for Neuroimaging Evidence of Pain

Judge Hoffman explicated several of the important issues that arise in the law relating to chronic pain, particularly pain that non-specialists might consider to be unusual.[173] According to Judge Hoffman, the major issue (elaborated more fully above) is that pain is "everywhere in the law," yet typical judges, jurors, and other decision makers "don't believe in" pain that they cannot see, that persists in the absence of an injury, or that seems in excess of what a non-specialist would expect for the condition.[174] He concluded with his opinion that neuroimaging or other scientific evidence that could help to address these issues would be tremendously helpful because "what we have now . . . is [almost] nothing."[175]

169. *Id.*; *see also* Shaun Cassin, *Eggshell Minds and Invisible Injuries: Can Neuroscience Challenge Longstanding Treatment of Tort Injuries?*, 50 HOUS. L. REV. 929, 937–38 (2001) (stating that people are doubtful of others' pain).

170. Panel 2, *supra* note 1, at 10–11; *see also* Madeira, *supra* note 161.

171. Panel 2, *supra* note 1, at 11.

172. *Id.*

173. *Id.* at 9–11.

174. *Id.* at 10; *see also, e.g.*, Cassin, *supra* note 169 (stating that understanding the pain of others is difficult and raises issue of doubt).

175. Panel 2, *supra* note 1, at 11.

Building on Judge Hoffman's comments, Professor Michael Pardo, a professor of evidence law who has published widely in the area of epistemology, law and neuroscience, and philosophy of law, offered his views on the considerations involved in deciding whether to admit neuroscience based evidence of chronic pain.[176] First, he offered legal and theoretical considerations that pertain to scientific evidence in general, and then provided specific insights relating to the neuroscience based evidence of pain.[177] He framed his remarks by noting that while he would address the law of evidence specifically by including factors like the Federal Rules of Evidence and the *Daubert* test for expert evidence, the issues in evidence law go beyond the Rules.[178] More fundamentally, he suggested that it is necessary to evaluate "evidence policy and the process of legal proof," which involve considerations ranging from the normative goals of the legal system to the ways in which legal actors and lay people engage in decision making.[179]

Professor Pardo opened with the framing assertion that, "[f]rom an evidentiary perspective, the fundamental issue that we're focusing on [in this and in any other legal arena] is trying to separate out true claims from false claims."[180] In this vein, Professor Pardo focused his comments on important issues in evidence law relating to the proof of claims and the scope of expert testimony.[181] Although not addressing individual pain variability itself, Professor Pardo's comments frame the evidentiary issues and choices common to the introduction of neuroimaging evidence on any contested point, in any matter.

To understand whether any kind of scientific evidence helps us to separate true claims from false claims, Professor Pardo explained that we need to understand "two different kinds of mistakes" that a test or other diagnostic material can produce.[182] There are "false positives," meaning that the evidence indicates that a claim is true when in fact it is false.[183] There are also "false negatives," meaning that the evidence indicates that a

176. *Id.* at 13.

177. *Id.* at 11–13.

178. *Id.* at 18.

179. *Id.* at 11; *see generally* Michael S. Pardo, *Evidence Theory and the NAS Report on Forensic Science*, 2010 UTAH L. REV. 367, 369–75 (2010) (providing a guide to the terms "evidence theory" and "legal proof").

180. Panel 2, *supra* note 1, at 12.

181. *Id.* at 18–20.

182. *Id.* at 12.

183. *Id.*; *see also* Simon A. Cole, *More Than Zero: Accounting For Error In Latent Fingerprint Identification*, 95 J. CRIM. L. & CRIMINOLOGY 985, 994–95 (2005) (explaining the idea of "false positives").

claim is false when in fact it is true.[184] These two categories of mistakes exist along with two categories of accurate results: true positives and true negatives.[185] So there are four kinds or categories of possible results from any scientific or medical evidence: true (accurate) positives; true (accurate) negatives; false positives; and false negatives.[186]

Professor Pardo emphasized that "[i]t's these four possibilities we should keep in mind when we're thinking about evidence policy" in deciding whether to introduce any type of scientific or medical evidence.[187] In considering whether to admit a new test into evidence, he noted that

> we should consider not only the results that the test will produce, but also the state of affairs that the *absence* of the test would produce; then we must evaluate which is the better state. A test [any test—not pain neuroimaging *per se*] might detect true claims that otherwise would go undetected. But it might also produce many false positives. So are we better off with a system wide level detecting more true claims but also screening in more false claims?[188]

Speaking of neuroimaging based evidence specifically, Professor Pardo commented that

184. Panel 2, *supra* note 1, at 12; *see also* Cole, *supra* note 183 (explaining the idea of "false negatives").

185. *See* CTR. FOR DEVICES & RADIOLOGICAL HEALTH, U.S. FOOD & DRUG ADMIN., GUIDANCE FOR INDUS. & FDA STAFF: STATISTICAL GUIDANCE ON REPORTING RESULTS FROM STUDIES EVALUATING DIAGNOSTIC TESTS 35 (2007), *available at* http://www.fda.gov/downloads/MedicalDevices/DeviceRegulationandGuidance/GuidanceDocuments/ucm071287.pdf (defining what qualifies as a true negative result and a true positive result); *see also* Devashish Sharma et. al., *The Concept of Sensitivity and Specificity in Relation to Two Types of Errors and its Application in Medical Research*, 2 J. RELIABILITY & STATISTICAL STUD. 53, 53–54 (2009) (explaining that when sick people are correctly diagnosed as sick, they are termed as "true positive," and when healthy people are correctly identified as healthy, they are termed as "true negative").

186. *See* CTR. FOR DEVICES & RADIOLOGICAL HEALTH, *supra* note 185, at 34–35 (defining the four categories as determined by the designated reference standard).

187. Panel 2, *supra* note 1, at 12. *See generally* Francis X. Shen, *Neuroscience, Mental Privacy, and the Law*, 36 HARV. J.L. & PUB. POL'Y 653, 660 (2013) (acknowledging the importance of neuroscientific evidence in courtrooms and the use of such evidence to craft public policy).

188. Panel 2, *supra* note 1, at 12; *see also* Michael S. Pardo, *The Nature and Purpose of Evidence Theory*, 66 VAND. L. REV. 547, 573 (2013) (describing the differences between introducing evidence in litigation and the theoretical issues surrounding evidence).

> on this issue of chronic pain, you might think, well, [admitting neuroimaging evidence of individual pain] would be terrible because it would lead to all sorts of mistakes [like] false positives. Or you might think this will be wonderful because we'll pick up lots of true claims we might miss. Well, that's really only half of the picture. We should also be comparing that with what the world would look like if we were to exclude this evidence. How many false negative claims would you have, for example, under that situation? That's why we need to keep these four possible outcomes in mind. And that's really just the starting point when you're thinking about evidence policy.[189]

Professor Pardo's observation that evidence must produce acceptable and useful rates of true positives and true negatives while not producing unacceptable rates of false positives or false negatives raises the important question of what constitutes acceptable and unacceptable rates of accurate and erroneous results. This is a mixed empirical and normative question. The empirical dimension asks: how good is the test?[190] The normative dimension asks: what is our tolerance for error, and for different kinds of errors in different legal and social contexts?[191]

The following example illustrates the combined empirical and normative dimensions of whether to admit a new diagnostic test into evidence. Imagine a test that somehow detects actual innocence amongst a population of incarcerated individuals. The test is 100 percent accurate in detecting wrongfully convicted persons, detecting every single person who was actually wrongfully convicted. But it also produces false positives: for every actually wrongfully convicted person it detects, it also identifies one other person as wrongfully convicted who is in fact guilty. Thus for every two people the test identifies as innocent, there is only a 50-50 chance that either individual is innocent. The question about whether to rely on such a test is essentially a normative one: because of the importance of not depriving an innocent person of his or her liberty and the horror we might feel at incarcerating an innocent person, we might tolerate this 50-50

189. *See* Panel 2, *supra* note 1, at 12; *see also* Shen, *supra* note 187, at 664 (explaining how the role of neuroscience has helped with assessing pain, suffering, and damages in litigation and how the data has, in some instances, had a material effect on case outcomes).

190. *See* Frederick Shauer, *Can Bad Science be Good Evidence? Neuroscience, Lie Detection, and Beyond*, 95 CORNELL L. REV. 1191, 1205 (2010) (acknowledging how evidence reliability and admissibility depends on the purposes of which the evidence is being used).

191. *Id.*

relationship between true and false positives. In the converse situation, where a test might result in the deprivation of liberty instead, we ought not to tolerate such a ratio. These normative and policy questions overlay the empirical questions, and likely vary between civil and criminal contexts as well as among the varied civil and administrative contexts.[192]

Professor Pardo commented that discussions about evidence tend to focus on individual determinations to admit particular evidence, but cautions that it is important to be mindful of the system level implications of whether certain evidence is admitted.[193] He noted that "allow[ing] certain kinds of evidence in" may result in "deterring or encouraging certain kinds of claims" in future cases.[194] Those future claims "may be true claims or they may be false claims."[195] Thus, evidentiary determinations can affect the pool of cases that come into the system. Further, decisions to admit or exclude certain evidence can "affect[] the way you create evidence for the next case. One reason to exclude evidence might be to get better quality evidence for the next set of cases, which is a relevant policy consideration."[196] Professor Pardo tied these remarks to Professor Greely's earlier comments about the development of a research culture around DNA testing and evidence as well as the important effects of the professionalization of DNA testing relative to other forensic sciences.[197]

Evidentiary determinations to admit or exclude certain kinds of evidence also affects "primary behavior"—that is, how people and entities

192. *See generally* Frederick Schauer, *Lie-Detection, Neuroscience, and the Law of Evidence* 1, 7 (Univ. of Va. Sch. of Law Public Law & Legal Theory Research Paper Series, No. 2012-49, 2012) (explaining how the use or non-use of science in the legal system involves normative questions in various contexts).

193. Panel 2, *supra* note 1, at 12; *see also* Pardo, *supra* note 188, at 568 (noting that a theory of evidence and proof must provide or rely upon a plausible explanation of how the micro- and macro-levels fit together); Jay D. Aronson, *The Law's Use of Brain Evidence*, 6 ANN. REV. L. & SOC. SCI. 93, 99–100 (2010) (explaining how many hypotheses are based on limited studies, and how more work needs to be done before evidence can be ready for use in the legal system).

194. Panel 2, *supra* note 1, at 12*; see also* Daniel D. Langleben & Jane Campbell Moriarty, *Using Brain Imaging For Lie Detection: Where Science, Law, and Policy Collide*, 19 PSYCHOL. PUB. POL'Y & L. 222, 224 (noting that emerging and recurring patterns of evidence may have future impacts on situations that have significant legal consequences).

195. Panel 2, *supra* note 1, at 12; *see also* Henry T. Greely, Remarks at the Regan Lecture: Neuroethics: The Neuroscience Revolution, Ethics, and the Law (Apr. 20, 2004), *available at* http://www.scu.edu/ethics/publications/submitted/greely/neuroscience_ethics_law.html (remarking how neuroscience may make different kinds of predictions about people and how claims can vary enormously, suggesting that these future claims may be either true or false).

196. *See* Panel 2, *supra* note 1, at 12 (explaining how neuroscience evidence methods may have substantial effects on almost every trial and on the entire judicial system).

197. *Id.*; *see also* Hon. Andre Davis, Karen D. Davis, & Hank Greely, Imaging the Brain, Changing Minds: Chronic Pain Neuroimaging and the Law Symposium, Panel 1: Legal and Neuroscientific Perspectives on Chronic Pain 26 (Apr. 25, 2014) [hereinafter Panel 1] (transcript on file with the editors).

act outside of court, Professor Pardo explained.[198] Evidentiary regimes affect how likely a party is to be subject to a lawsuit, which then might deter a party from certain conduct.[199] Then, we have to ask, "[i]s that conduct [that is being deterred] good conduct or bad conduct, socially good or socially bad?"[200] In summary, Professor Pardo noted that in considering whether new, brain based evidence on chronic pain should be admissible, we need to consider the four kinds of results we might get, the effects on the next set of cases, and the effects on primary behavior.[201]

These kinds of evidence policy questions also intersect with how judges, jurors, and others interpret and make sense of evidence. "The significance of evidence isn't something that comes stamped on the evidence. Evidence isn't self-defining," Professor Pardo explained.[202] Instead, the beliefs of jurors and judges (or whoever the decision maker is) "are a necessary part of the process."[203] Professor Pardo asserted that evidence must go well beyond the rules or any particular admit-or-exclude decision.[204] It extends to how legal decision makers (judges, jurors, and administrative personnel) think about claims, claimants, and kinds of proof in order to reach their decisions.[205] A basic aspect of how the legal system works involves the process in which the fact finder's "knowledge, beliefs,

198. Panel 2, *supra* note 1, at 12; *see also* Pardo, *supra* note 188, at 554–55 (explaining the practical significance of evidence theory and how it extends well beyond trials); Jane Campbell Moriarty, *Visions of Deception: Neuroimages and the Search for Truth*, 42 AKRON L. REV. 739, 760 (2009) (describing how the field of neuroscience is developing outside of the courtroom in multiple settings).

199. *See* Pardo, *supra* note 188, at 554 ("[T]he evidentiary rules and standards also determine important issues such as who gets to trial in the first place, which verdicts will be allowed to stand, and which convictions will be overturned.").

200. Panel 2, *supra* note 1, at 12.

201. *Id.*

202. *Id.*; *see also* Michael S. Pardo, *Neuroscience Evidence, Legal Culture, and Criminal Procedure*, 33 AM. J. CRIM. L. 301, 322 (2006) (explaining how neuroscience tests arguably are qualitatively different since they compel inductive evidence of mental events, beliefs, thoughts, and propositional knowledge); Owen D. Jones & Francis X. Shen, *Law and Neuroscience in the United States*, INT'L NEUROLAW: A COMPARATIVE ANALYSIS 349, 357 (2011), *available at* http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2001085 (noting that new brain imaging and brain monitoring technologies have created problems for judges, jurors, and the like regarding the admissibility and proper interpretation of evidence).

203. Panel 2, *supra* note 1, at 12; *see also* Amanda C. Pustilnik, *Painful Disparities, Painful Realties* 6 (Univ. of Md. Francis King Carey Sch. of Law Legal Studies Research Paper No. 2014-18, 2014), *available at* http://digitalcommons.law.umaryland.edu/cgi/viewcontent.cgi?article=2449&context=fac_pubs (stating that judges and jurors frequently need to evaluate evidence of chronic pain); Jones & Shen, *supra* note 202, at 353 (acknowledging that the justice system relies critically and fundamentally on the judges, jurors, lawyers, etc.).

204. Panel 2, *supra* note 1, at 20.

205. *Id.* at 12; *see also supra* text accompanying note 203.

[and] assumptions will combine with the trial evidence."[206] It is this combination of evidence with the decision makers' background knowledge and beliefs that result in the decision makers' "reach[ing] particular conclusions [and] draw[ing] particular inferences. Without these background beliefs, the evidence goes nowhere."[207]

The legal system's reliance on the background beliefs and knowledge of decision makers can be beneficial. But in areas where decision makers are poorly informed or tend to hold mistaken beliefs, it also can lead to predictable and intractable problems. In "turning to the question of juror beliefs or juror assumptions about chronic pain and about objective, scientific evidence on chronic pain," Professor Pardo stated that he sees "a potential opportunity and a potential analogy with what is called 'social framework evidence.'"[208]

Social framework evidence comes into a trial in

> situations where experts are called upon to summarize phenomena for the jury that might be inconsistent with their mistaken background beliefs. Potential categories for this in the social science context could include: eyewitness identification, such as when, as a general matter, are eyewitnesses likely to make mistakes; false confessions, where jurors may believe it is not possible that anyone who is innocent would confess to a crime, but we know there are lots of situations in which that might occur—giving the jury background information like that could be helpful; issues about gender and racial bias in employment cases is

206. Panel 2, *supra* note 1, at 12; *see also* Owen D. Jones, *Seven Ways Neuroscience Aids Law*, *in* NEUROSCIENCES AND THE HUMAN PERSON: NEW PERSPECTIVES ON HUMAN ACTIVITIES 1, 8 (2013), *available at* http://www.casinapioiv.va/content/dam/accademia/pdf/sv121/sv121-jones.pdf ("[T]he legal system's frequent dependence—typically without knowing it—on what are, at base, neuroscientific assumptions.").

207. Panel 2, *supra* note 1, at 12; *see also* Shauer, *supra* note 190, at 1208–09 (explaining how slight or even weak evidence may often aid in a holistic creation form, or for the related purpose of creating an inference as to the best explanation).

208. Panel 2, *supra* note 1, at 12–13. "Social framework evidence" is a term first coined by the legal scholars, John Monahan and Laurens Walker, in their article: *Social Frameworks: A New Use of Social Science in the Law*. Laurens Walker & John Monahan, *Social Frameworks: A New Use of Social Science in Law*, 73 VA. L. REV. 559, 576 (1987). The proper scope and limits of social framework evidence remain hotly debated by evidence scholars, in part because of questions about the validity and rigor of some of the social science research in which social framework evidence may be based. *See id.* (noting that aggregate evidentiary information is likely highly undervalued by law decision makers).

> another popular example with regard to social framework evidence.[209]

Expanding on this practice of social framework evidence in these areas, there could be

> something similar in this context, call it "neuroscientific framework evidence," where you can have an expert who can come in and educate the jury about basic background assumptions that might be mistaken, such as the fact that chronic pain does exist, and that at least for some people, they experience this phenomenon without having certain kinds of visible physical markers like a missing limb.[210]

In considering whether neuroscientific framework evidence would be valuable, Professor Pardo commented that if one party were to make the strong argument that a certain "kind of chronic pain symptom simply does not exist," and therefore the claimant should be believed, that would "make[] the case for admissibility [of educative evidence] a lot higher."[211]

Another important evaluation that Professor Pardo pointed out consists of the comparison between a party's claim and the judges' or jurors' "background beliefs and assumptions" that may be mistaken, but on which the system relies.[212] A significant gap between a decision maker's knowledge and beliefs and the (possibly meritorious) claims by a party also present a context in which an expert could provide educational or framework evidence.[213] If a party seeks to "correct those [mistaken beliefs or assumptions], that's one potential avenue for admitting expert testimony

209. Panel 2, *supra* note 1, at 12–13; *see also* Walker & Monahan, *supra* note 208, at 565 (explaining how social science may encapsulate ordinary human experiences and provide appropriate frames of reference with respect to a jury's consideration).

210. Panel 2, *supra* note 1, at 13. "[E]xpert scientific testimony must present information that is outside the 'common knowledge' of the average layperson. These rules suggest that empirical frameworks must provide fact finders with information they do not already have." Walker & Monahan, *supra* note 208, at 578.

211. Panel 2, *supra* note 1, at 13; *see also* Walker & Monahan, *supra* note 208, at 572 (explaining how the framework that makes any fact in the case more or less probable poses a difficult issue rather than a concrete probability).

212. Panel 2, *supra* note 1, at 13. *See* Frederick Schauer, *On the Supposed Jury-Dependence of Evidence Law*, 155 U. PA. L. REV. 165, 189 n. 193 (2006) (illustrating the willingness of judges, even more so than juries, to convict in criminal cases based on their beliefs about the defendant and beyond what was presented as evidence in the trial).

213. *See* David Jaroslaw & Wendy Michael, *The Expert Witness as Teacher: How a "Neutral" Tutorial Can Enhance a Jury's Understanding of Your Case*, 62 FDCC QUARTERLY 156, 156 (2012) (describing how expert witnesses can educate juries and judges on unfamiliar subjects so that the lawyer can then persuade them with the facts of the case).

on this topic."[214] If framework evidence about the neuroscience of chronic pain were to be admitted on this basis, Professor Pardo suggested that it would first be important to gather data on "what it is that judges and juries don't understand" in relation to the evidence and the claims that they are being called upon to evaluate.[215]

Formal rules of evidence, judicially created case law concerning evidence, and statutes and regulations can also significantly affect the weight and power of certain kinds of evidence, Professor Pardo explained.[216] As a matter of law, certain evidence can "create a presumption" in one direction or another.[217] Some presumptions are rebuttable, meaning that the party against whom the presumption is drawn can come forward with evidence that overcomes the presumption.[218] Other presumptions are "irrebuttable," meaning that the party cannot overcome the presumption; if certain evidence is present, jurors *must* reach one, and only one conclusion.[219] Other strictures also may constrain the purposes for

214. Panel 2, *supra* note 1, at 14. *See also* Edmund S. Higgins & Bruce S. Skinner, *Establishing the Relevance of Expert Testimony Regarding Eyewitness Identification: Comparing Forty Recent Cases with the Psychological Studies*, 30 N. KY. L. REV. 471, 472–73, 481 (2003) (suggesting that using expert testimony about the fallibility of eyewitness recall would help correct jurors' inaccurate assumptions, decreasing the number of wrongful convictions).

215. Panel 2, *supra* note 1, at 14.

216. *Id.* at 20–22 (describing examples of cases such as *Daubert v. Merrell Dow Pharmaceuticals*, 509 U.S. 579 (1993), statutes such as the Federal Coal Mine Health and Safety Act, and different presumptions from the legal rules of evidence that could impact the way pain evidence is handled in future cases).

217. *See, e.g.*, David Kaiser, P*resumptions of Law and of Fact*, 38, MARQ. L. REV. 253, 255, (1955) (describing how evidence that someone has been missing for seven years without making contact with anyone can be used to presume that, for legal purposes, the missing person is dead).

218. *See* BLACK'S LAW DICTIONARY (9th ed. 2009) (defining "rebuttable presumption"). To illustrate: one ancient common law presumption is that people intend the natural and probable consequences of their actions. *See* Michael G. Heyman, *The Natural and Probable Consequences Doctrine: A Case Study in Failed Law Reform*, 15 BERKELEY J. CRIM. L. 388, 395 (2010) (defining the doctrine and showing how some presumptions can be challenged and ultimately overturned). An additional example: if a person hurls a baseball at the window of a house, jurors may presume that she intended to break the window. This is a "rebuttable presumption," however, and may be overcome if the party provides compelling evidence that she did not intend to hurl the ball or that she had an alternative reason for so acting, e.g., the owner of the house invited her to play ball against the new, unbreakable glass he installed.

219. *See* BLACK'S LAW DICTIONARY (10th ed. 2014) (defining "conclusive presumption," which is also known as an irrebuttable presumption). A common irrebuttable presumption relates to intoxication. By statute, a person whose blood alcohol level exceeds the legal limit for the jurisdiction is presumed to be drunk. Jurors presented with evidence that a driver's blood alcohol was over the legal limit cannot decide among themselves based on other evidence that the driver had a higher tolerance; as a matter of law, that driver was drunk. *See* State v. Childress, 274 P.2d 333, 335 (Ariz. 1954) (holding that a blood alcohol level that exceeds the legal limit conclusively proves that the driver was intoxicated, thus creating an irrebuttable presumption). *See The Irrebuttable Presumption Doctrine in the Supreme Court*, 87 HARV. L. REV. 1534 (1974) (discussing a series of opinions in which the Supreme Court has developed a doctrine dealing with "irrebuttable presumptions").

which jurors may consider the evidence.[220] Jurors may be able to consider certain evidence for one purpose but not for another.[221] Similarly, an expert providing framework evidence may be limited in his or her testimony in providing information about research findings and data on the subject in question, but may not opine about the ultimate issues in the case.[222]

This range of presumptions, restrictions, and guidelines could apply to neuroimaging based testimony and evidence as well. "At the strongest level," Professor Pardo commented, "we could say having this kind of objective evidence (say, neuroimaging or anything else) is so good that we're going to create an irrebuttable presumption, that if you have this kind of objective evidence, you win."[223] Certain federal regulations provide precedent for treating medical or scientific evidence this way.[224] Professor Pardo described the Federal Coal Mine Health and Safety Act, which "says that if you have clinical evidence of certain kinds of lung disease, you are irrebuttably presumed to be disabled. There's no further fact finding that

220. *See infra* text accompanying notes 221–22.

221. *See* Michael H. Graham & Robert S. Glazier, *Subsequent Remedial Measures: The Misunderstood Rule of Evidence*, LXXII FLA. B.J. 40 (1998) (noting that this evidence can be submitted, but only if it is considered for certain purposes). For example: in tort law, if a plaintiff claims to have been injured on some allegedly negligently maintained property, the plaintiff can admit evidence that the property owner made repairs to the property after the accident. Jurors may consider this evidence for various purposes, such as whether the owner had control over the property or whether repairs were feasible. But, as a matter of law, they may not consider the fact of the subsequent repair to infer that the property was dangerous and negligently maintained prior to the repair.

222. *See* FED. R. EVID. 704 (stating that experts may provide their opinions on the ultimate issue in the case except when the expert is testifying about the mental state of a defendant in a criminal case, where only the trier of fact may decide the "ultimate issue" of whether the person did or did not have the required mental state to commit the crime).

223. Panel 2, *supra* note 1, at 20. *See* BLACK'S LAW DICTIONARY (9th ed. 2009) (describing the tort concept of res ipsa loquitor, which is Latin for "the thing speaks for itself"). Res ipsa loquitur is a rebuttable presumption, in the sense that if the defendant can prove that the object was in fact not under his control, then he was not negligent. *See* Maroules v. Jumbo, Inc., 452 F.3d 639, 8–12 (2006) (explaining the different ways both parties could try to support or disprove a claim of control in a res ipsa locator case). However, there has been a lot of push back on scientific evidence being used as an irrebuttable presumption of guilt in litigation. *See* Stephen G. Thompson, *The Constitutionality of Chemical Test Presumptions of Intoxication in Motor Vehicle Statutes*, 20 SAN DIEGO L. REV. 301, 302–04 (1983) (expressing concern that cases that rely on breath testing of blood alcohol levels to convict drunk drivers if they are over a statutorily determined limit is a violation of due process); *see also* Brie S. Rogers, *The Presumption of Paternity in Child Support Cases: A Triumph of Law Over Biology*, 70 U. CIN. L. REV. 1151 (2002) (noting that in family law cases, there is a legal presumption for the husband of his wife's child to legally be the father, even if the biological DNA evidence conclusively demonstrates that he is not the biologically the father).

224. *See, e.g.*, Federal Coal Mine Health and Safety Act of 1969, Pub. L. No 91-173, 83 Stat. 742 (creating certain irrebuttable presumptions relating to coal miners who are diagnosed with black lung disease).

has to occur—having this evidence means you get benefits."[225] Similarly, "if your blood alcohol level is above a certain level, you are presumed irrebuttably to be drunk. You don't get to come to court and say, 'well, my tolerance is higher.'" If neuroimaging evidence of chronic pain were to become sufficiently diagnostically accurate, we could have something similar if we have really good evidence of chronic pain.[226]

> Less strong than actual regulation, however, we could still have a kind of presumption that's rebuttable but that's mandatory. That says that, if you have this evidence, we're going to presume that you have chronic pain, and it's up to the other side either to disprove it, or to introduce some evidence on that issue. If not, then you win as a matter of law.[227] We could have a non-mandatory, sort of permissive presumption . . . . It's just a standardized comment on the evidence, or an instruction to the jury telling them, "if you find that there is this evidence and you find it credible, you may infer pain [just] from this evidence alone. You don't have to, but you may." . . . So there [are] a whole [set] of regulation[s] or options available to the law in regulating what we do with this evidence beyond just the admitted or excluded.[228]

Professor Robert Dinerstein commented on Professor Pardo's remarks, observing that presumptions and other evidentiary rules "are not necessarily rules of science" or even rules that incorporate scientific findings.[229] Instead, evidentiary rules, presumptions, and features of regulations (as with the Federal Coal Miner's Act) may embody both normative and policy

225. Panel 2, *supra* note 1, at 21; *see also* Federal Coal Mine Health and Safety Act of 1969 § 411(c)(3).

226. Panel 2, *supra* note 1, at 19. *But see* Thompson, *supra* note 223 (raising constitutional concerns, in light of recent Supreme Court cases, that these types of presumptions violate due process).

227. Panel 2, *supra* note 1, at 19. *See also* Francis v. Franklin, 471 U.S. 307, 317 (1985) (describing a mandatory rebuttable presumption and the resulting burden shifting between parties).

228. Panel 2, *supra* note 1, at 20. *See* Peter Widulski, *NY Court of Appeals Addresses Another Statutory Presumption*, PACE CRIM. JUST. BLOG, (Oct. 28, 2014), http://pcjc.blogs.law.pace.edu/2014/10/28/ny-court-of-appeals-addresses-another-statutory-presumption/ (describing jury instructions for a permissive presumption).

229. Panel 2, *supra* note 1, at 19. *See* Joseph T. Walsh, *The Evolving Standards of Admissibility of Scientific Evidence*, 36 JUDGES' J. 33 (1997) (illuminating the tensions between the increased amount of scientific evidence available and legal procedure).

considerations.[230] An important policy consideration that can influence rules and regulations is the question of "how much is it worth . . . [to] spend the time it would take . . . trying to do some fact finding," versus the question of whether it is more efficient to "just presume" in one direction or another when certain facts are present.[231]

230. *See infra* text accompanying note 231.

231. Panel 2, *supra* note 1, at 20.