Dædalus

Journal of the American Academy of Arts & Sciences

Fall 2018

Science & the Legal System

Shari Seidman Diamond & Richard O. Lempert,
guest editors

with Sheila Jasanoff · Linda Greenhouse
Jules Lobel · Huda Akil · Rebecca S. Eisenberg
Robert Cook-Deegan · Jed S. Rakoff
Elizabeth F. Loftus · Jennifer L. Mnookin
Joseph B. Kadane · Jonathan J. Koehler
Nancy Gertner · Joseph Sanders · Daniel L. Rubinfeld
Joe S. Cecil · Valerie P. Hans · Michael J. Saks
David Baltimore · David S. Tatel · Anne-Marie Mazza

Introduction

Shari Seidman Diamond & Richard O. Lempert

SHARI SEIDMAN DIAMOND, a Fellow of the American Academy since 2012, is the Howard J. Trienens Professor of Law and Professor of Psychology at the Northwestern University Pritzker School of Law, and Research Professor at the American Bar Foundation.

RICHARD O. LEMPERT, a Fellow of the American Academy since 1993, is the Eric Stein Distinguished University Professor of Law and Sociology, emeritus, at the University of Michigan.

(Complete author biographies appear at the end of the essay.)

Experts bedeviled the legal system long before seventeenth-century Salem, when the town's good citizens relied on youthful accusers and witchcraft experts to identify the devil's servants in their midst. As in Salem, claims of expertise have often been questioned and objections raised about the bases of expert knowledge. Expertise, then and now, did not have to be based on science; but the importance of science and the testimony of scientific experts has since medieval times been woven into the fabric of the English jurisprudence that Americans inherited. In cases as long ago as 1299 we find examples of courts seeking help from "scientists." In that year, physicians and surgeons in London were called on to advise the court on the medical value of the flesh of wolves.[1] In 1619, two physicians offered the opinion that a wife could bear a legitimate child "forty weeks and nine days" after the death of her husband.[2] Throughout this period, medical authority was called on by the coroners' courts to determine whether a death was due to suicide or to other causes, a crucial determination because suicide was a felony that entitled the Crown to take possession of a deceased's estate.[3] Medical testimony is still the most common form of scientific expertise presented in court, but expert advice on legal matters has expanded exponentially, reflecting the enormous range of scientific knowledge that modern scholarship has produced.

Although recognizing the need for scientific assistance, judges soon learned that sources claiming scientific expertise did not always agree. For example,

© 2018 by Shari Seidman Diamond & Richard O. Lempert
doi:10.1162/DAED_x_00516

in the 1781 trial of *Folkes v. Chadd*, the issue was whether the construction of an embankment, as opposed to natural forces, had caused the deterioration of Wells Harbor. The first trial introduced engineering testimony from a well-credentialed Fellow of the Royal Society. By the third trial in 1783, prestigious engineering experts testified on both sides and were subjected to vigorous cross-examination. The disagreement, in retrospect, was understandable: more than two hundred years later, science still cannot provide a definitive answer to the question posed in that litigation.[4] Yet the legal system then as now needed to resolve the dispute between the parties, and the scientific evidence offered was the best they had to work with. As the trial system and the law of evidence developed, courts and juries have continued to struggle to make use of the conflicting expert advice they receive. Judges and juries, lacking the scientific knowledge of experts, both face difficult challenges in understanding and applying expert scientific testimony. Not surprisingly, they occasionally get the science they are supposed to evaluate wrong, and what the legal system has accepted as sound science has not always withstood the test of time.

How well factfinders do in understanding and applying science is a matter of some controversy, but it is not the only issue that arises at the interface of law and science. The two fields are in many ways culturally distinct. Good science often involves the withholding of judgment until more evidence has accumulated. The law requires that decisions be reached upon the conclusion of trials regardless of gaps in the available evidence. Science seeks empirical truths regardless of their implications, and scientists ideally share in a common truth-seeking mission. Litigants aim at persuading a judge or jury to favor their side regardless of where the truth lies; harsh questioning and emotional appeals are not out of bounds if they serve that end, even when it is scientists being questioned. Often in modern litigation, the law must be informed by scientific evidence as communicated by the views of the scientists who present it. These are typically experts chosen and paid by parties because, regardless of the law's needs, scientists, with rare exceptions, cannot be forced to contribute what they know. Science is in principle always open to revision as additional evidence accumulates. The law can be slow to change and its treatment of science may be determined by precedent, even when a scientific consensus recognizes that the science that supported the precedent is no longer regarded as sound.

The essays in this volume deal with tensions and areas of overlapping interest at the interface of science and the legal system. Many of the essays are written by scientist-lawyer teams. This is no accident; in selecting authors we tried wherever possible to match across disciplines to highlight and bridge potential gaps in perspectives. In some cases, we selected single authors who themselves are both scientists and legal scholars. Our goal was to avoid the silo mentality that too often creates obstacles to useful discourse between science and law.

The essays in this issue are divided into three sections. The essays in the first section examine the science-law interface by focusing attention on two sets of key players: the judges who determine what scientific evidence will be considered by the legal system, and the scientists and engineers with the expertise to provide that assistance. The authors of the first two essays have closely studied the history, discourse, and decision-making of U.S. courts when they are called on to deal with scientific evidence as gatekeepers and decision makers. The third essay provides a perspective from the other side of the law-science divide. It presents the first published survey

results from a sample of distinguished scientific and engineering experts who were asked about their views of the legal system and about their participation in it (or not).

The five essays in the second section provide insights into the interactions between scientific expertise and the legal system by focusing on specific fields: neuroscience, patents, eyewitness identification, forensic evidence as a whole, and fingerprint evidence in particular. Each of these contributions highlights what science can offer, but also analyzes the obstacles that arise in obtaining and evaluating scientific advice in a legal context.

The authors in the third section tackle the difficult procedural challenges posed by the interaction between scientific experts and legal factfinders. These three essays consider modest and not-so-modest changes to the traditional conduct of American legal proceedings that might improve both the presentation and evaluation of scientific evidence.

The issue closes with a look at the continuing dialogue between members of the scientific and legal communities.

Now for a closer look.

In the volume's opening essay, Sheila Jasanoff addresses an issue fundamental to any discussion of science and the law: what determines the reception given ostensibly scientific claims when they enter the legal system and are reinterpreted in a legal context? Jasanoff argues that judicial common sense, rooted in judges' cultural understandings, forms the lens through which scientific claims are assessed by courts. She makes a powerful case for her view of how judicial authority and judges' commonsense understandings of the import and validity of scientific claims provide the standards that effectively determine how scientific evidence is perceived and used by courts. Her perspective cautions against analyses that too frequently begin and end with *Daubert v. Merrell Dow Pharmaceuticals*, the Supreme Court case that firmly established the judge's role as gatekeeper when courts are offered scientific evidence. She uses an extensive analysis of *Kumho Tire Co. v. Carmichael*, a case that made it clear that *Daubert* extended to engineering and technical experts to show how the standards for admitting scientific evidence, which the *Daubert* court tried to draw from their understanding of how scientific truths are established, are easily submerged by judges' commonsense perspectives on what methods and theories make for sound scientific or technical conclusions. Her analyses of later cases highlight limits on the guidance that *Daubert* can give, for science may background some legal questions but be unable to answer them.

In closing her essay, Jasanoff argues that one cannot expect judges to think like scientists when evaluating scientific evidence, but she contends that we can demand of judges who confront scientific issues more than unreflective common sense. The challenge is not to make scientists of judges but rather to reflect on how judges should go about thinking about science and to find ways of encouraging judges to appreciate what science can tell them and see beyond their own common sense. Although Jasanoff does not say it, the task becomes more difficult as ideology affects judgments.

Linda Greenhouse, closely scrutinizing how members of the U.S. Supreme Court have responded to scientific evidence, provides a detailed study of the ways that law and medical science have intertwined in the jurisprudence surrounding abortion, beginning with *Roe v. Wade*. Greenhouse tells us that the case law began with a focus more on protecting medical doctors in their exercise of professional judgment from the threat of prosecution than on the interests that pregnant women had in choosing to terminate a pregnancy. As Greenhouse de-

scribes the case law, an elaborate dance has been occurring between science and the law, with each in turn taking steps forward and back. Which partner is moving forward depends on legal understandings of the deference courts owe legislative fact-finding and limits on this deference when the facts do not even arguably stand up to scientific scrutiny.

In *Whole Woman's Health v. Hellerstedt*, for example, the question was whether courts should defer to the Texas legislature's assertion that protecting the safety of women getting an abortion requires that doctors who perform abortions must have hospital admitting privileges (a requirement that would, in effect, close most abortion clinics). The U.S. Supreme Court rejected the legislation, which ignored the compelling medical evidence that requiring hospital privileges does nothing to protect women needing more medical attention than a clinic can provide. But the path to the Supreme Court's decision was rocky. The decision of the District Court that initially heard the case, finding that the facts were inconsistent with the legislative claim, was reversed by the Circuit Court on appeal on the respectable-in-theory but unjustified-in-context claim that federal courts should defer to legislative fact-finding on the need for health-related regulation. The Court of Appeals also refused to stay its decision pending appeal to the Supreme Court. By the time the Supreme Court eventually upheld the District Court's decision enjoining enforcement of the statute, in 2016, about half of Texas's abortion providers had permanently closed their doors. Although science-based evidence eventually prevailed in this case, an important lesson from this dance between law and science is that judges vary in their openness to what science and technology can offer, with ideology sometimes motivating a failure to accept even strong scientific evidence.

We, Shari Diamond and Richard Lempert, coeditors of this volume, describe the results of a survey that many Academy members participated in – our thanks! Conducted with the cooperation of the American Academy of Arts and Sciences, the survey examines the views of the legal system held by some of the nation's most distinguished scientists and engineers, including what motivates them to participate or to refuse to participate in lawsuits when asked. We began the project with some doubt that the legal system was soliciting assistance from the kinds of scientific and engineering experts whose accomplishments have led to Academy membership – or that, perhaps, such experts were being asked but were unwilling to participate. The results showed that these concerns were unwarranted. A majority (54 percent) of respondents reported having been asked for advice, and most of those asked had agreed to participate at least once.

Nonetheless, we found that the experts reported that lack of time frequently limited their participation, and that they sometimes turned down requests due to a discrepancy between their area of expertise and the scientific issues they were asked about, suggesting that greater participation might be promoted through a more effective matching system. In addition, respondents endorsed several potential changes in procedures used by the legal system that might increase their willingness to participate. Some of these potential changes are discussed in greater depth in the third section of this volume. Finally, we found an intriguing relation between participation and belief in the ability of the legal system to deal well with scientific matters, including some evidence that participation fuels higher opinions. This is a relationship that deserves further investigation.

More than any other contribution to this volume, Jules Lobel and Huda Akil's essay

on law and neuroscience is positioned on an active and changing border between law and science. Courts are increasingly being asked to consider neuroscience evidence. To date, neuroscience has had the greatest impact on legal processes on the criminal side, where neuroscience evidence can reveal deficiencies in an accused's brain that suggest the intent behind a criminal action was in part the result of physiological abnormalities. The evidence can even have constitutional significance, as in *Roper v. Simmons*, the case that barred executing juveniles, influenced in part by evidence regarding the neurological development of youthful brains. Civil litigation too may be transformed by neuroscience. The civil justice system has long resisted awarding damages or other relief based on emotional pain unaccompanied by noticeable physical harm. Such suits were regarded with suspicion because of the subjective nature of claims of emotional harm and the difficulties of finding objective proof. But to the extent that neuroscience can provide imaging evidence that a claimant's brain deviates from normal human physiology, the claim of emotional harm is objectively supported and physical harm is shown to be present.

Much of the Lobel-Akil essay is devoted to a close look at cases arguing that long-term solitary confinement is unconstitutionally cruel and unusual. Although lawyers opposing extended solitary confinement have few if any scientifically rigorous studies of people to draw on, considerable animal research and a body of neuroscience theory supports the claim that people's brains undergo seriously harmful and likely permanent changes when they are denied social contact and environmental stimulation over long periods of time. To the extent this new research moves the dial on the practice and legality of long-term solitary confinement, it will also tell us something about the law. Most people, judges included, do not need neuroscience to convince them of the horror of isolating people in small confined spaces with almost no social contact for years on end. Yet the law may need scientific evidence in support of what almost everyone knows before it will discard the fiction that solitary confinement differs simply in degree, rather than in kind, from the normal deprivations that anyone imprisoned suffers. This may be one area in which scientific evidence can resolve differences between conflicting commonsense beliefs.

Rebecca Eisenberg and Robert Cook-Deegan write about an area in which science and the law are intertwined to the point where they cannot be untangled: the U.S. patent system. The authors focus their attention on the Bayh-Dole Act, which changed prior law by not only allowing but also encouraging organizations that develop patentable inventions through research funded by federal agencies to acquire proprietary rights to these inventions. The goal was to promote the commercialization of the fruits of federally funded science. Universities were the most visible intended beneficiaries, and the image of universities as entities working for the common good by advancing and sharing knowledge created halo effects without which Bayh-Dole might never have become law. The benefits of Bayh-Dole were, however, later extended from nonprofits and small businesses to large corporations by a low visibility amendment.

Eisenberg and Cook-Deegan document the effects of Bayh-Dole by focusing on how universities responded to their new rights in light of the income streams these rights enabled. In many cases, it appears, monetary concerns dwarfed whatever perceived commitment to the common good universities benefited from when the case was made for Bayh-Dole and in their later patent-related legislative lobbying. In a number of instances, universities claimed

patent rights to stifle or extract profits from commercial activities that seemingly would have occurred without a university's patentable contributions. Indeed, some universities have gone further, on occasion selling their rights to patent trolls who make their money by threatening to disrupt or prevent commercialization. Senators Bayh and Dole would, one suspects, not be pleased by some university actions their law has enabled.

Eyewitness testimony, the subject of Judge Jed Rakoff and Elizabeth Loftus's essay, is the single most common factor contributing to wrongful convictions for serious crimes. Rakoff and Loftus briefly discuss why eyewitness testimony is such powerful evidence before reviewing what we know about the causes of mistaken eyewitness identifications. They then explore efforts that have been made to increase eyewitness accuracy and to help factfinders assess the strengths and weaknesses of eyewitness testimony in trials. Their essay not only reports ways in which the social sciences have been used to identify weaknesses in eyewitness testimony and ways to ameliorate them, but also documents ways in which this knowledge has led to procedural reforms designed to increase the accuracy of eyewitness testimony and the ability of jurors to evaluate it.

A key distinction made by the authors is the difference between system variables and estimator (or witness) variables. The former has to do with the way eyewitness identifications are elicited: how lineups are constructed, for example. Problems of this sort are relatively tractable, and in many states, scientific findings have led to promising procedural change. Problems posed by the latter – that is, by weaknesses inherent in human observation and memory – pose far more difficult challenges. The best we may be able to do, Rakoff and Loftus suggest, is to educate judges and jurors on factors that, if present, make eyewitness identifications problematic so that they can do a better job of weighing an identification's probative value.

Jennifer Mnookin succeeds in presenting, in remarkably brief compass, an informative account of the state of forensic science today. After effectively acquainting readers with the forensic identification sciences, she highlights issues that are now dominating discussions both within the forensic science community and among the leading critics of forensic science procedures, protocols, and modes of testifying. Mnookin herself has been an important and respected participant in these discussions, especially as they relate to friction ridge (fingerprint) identifications, and one can see why. Her positions are not dogmatic, nor are they entirely critical; rather they both recognize deficiencies in forensic science technologies and ways of testifying, and acknowledge efforts being made, including efforts by forensic science practitioners, to improve the quality and characterizations of the forensic science evidence they offer.

She supports her claim that one may see the current state of the forensic identification sciences as a glass half empty or half full by reference to a pair of contrasting bite mark identification cases that arose in the states of Connecticut and Pennsylvania within months of each other. In the Connecticut case – a review of a 1991 murder conviction in which bite mark evidence played a major role – the defense, the prosecution, and the scientist who presented the original bite mark evidence agreed that the bite mark identification was worthless, with the expert even calling his earlier testimony "junk science." Combined with corroborating DNA evidence, the judge vacated the murder conviction and reopened the case. In the Pennsylvania case, the trial judge refused to even hold a full hearing to determine if the bite mark evidence offered by

the prosecution was sufficiently reliable to be admitted, citing precedent that allowed it. The two cases may be distinguished, but the weaknesses of bite mark evidence are so well known that if it is regarded as sufficiently reliable to be admitted, judicial barriers against other frequently offered forensic science evidence would seem unlikely, no matter how frail the evidence's scientific underpinnings. Mnookin believes, however, that further reform is possible, and identifies collaboration between research scientists and stakeholders in the legal system as the best hope for transformative change.

Because uncertainty attaches to all forensic science claims, effectively communicating levels of certainty to factfinders is crucial to accurate fact-finding. Joseph Kadane and Jonathan Koehler present results from an experiment that tests whether the words that fingerprint examiners use to express their conclusions affect the weight that laypersons give reports of possible matches. They find that the two most scientifically defensible ways of reporting on fingerprint comparisons, neither of which claims that two fingerprints indisputably match, have the effect of moderating judgments, when compared to other ways that examiners might express opinions that two fingerprints match. If an examiner is willing to say that she thinks two fingerprints match, respondents are not sensitive to differences in the language used to fortify that opinion.

This study is important early research, an original study using a brief written transcript and nondeliberating mock jurors, but it is a first step. Research in other areas where social science findings have affected legal procedures, such as the eyewitness reforms discussed in the Rakoff-Loftus essay, began with similar small steps, followed by more elaborate studies in the laboratory and in the field. Kadane and Koehler's findings are intriguing enough that they should stimulate research to confirm what they have found, helping both scientists and the legal system to hone in on ways that protocols for communication can improve practice.

Shari Seidman Diamond & Richard O. Lempert

Nancy Gertner and Joseph Sanders begin their essay by suggesting that two principal goals of judicial trials, accuracy and fairness, are not consistent. Accuracy references an objective standard, while fairness lies in the eyes of the beholder. Gertner and Sanders cite research suggesting that, consistent with the American model of adversary litigation, people see decisions that affect them as fairer when they have had an opportunity to provide information to the decision maker and to have their stories heard. Accuracy, on the other hand, is thought by some as likely to increase when an expert judge closely controls proceedings and witnesses are not identified with parties. When scientific matters are at issue, not only does party control lead to the biased selection of experts who may not be representative of the best available expert opinion, but serving as a party witness can color expert evaluations and the way experts report their findings, even when they think they are being objective.

Having laid out the potential tension between accuracy and fairness and the research pointing to it, Gertner and Sanders explore suggested reforms aimed at enabling more accurate evaluations of scientific evidence within the general confines of the American adversary system. These include readjusting the order of testimony so that opposing experts testify in temporal proximity to each other; adopting the Australian procedure of "hot tubbing," in which experts appear together before the factfinder to present and discuss their differing views; and making changes in jury procedure likely to increase the ability of jurors to understand expert testimony and better judge where the weight of the scientific evidence lies. The authors explore not

just the potential benefits from such changes but also potential downsides and difficulties of implementation. Implicit in the Gertner-Sanders essay is a message more explicitly stated in other contributions: while we can be confident that some reforms, mainly relating to jury management, are likely to improve the evaluation of expert testimony, we need more research that targets other reforms, particularly those relating to expert selection, information sharing, and the presentation of expert testimony.

Daniel Rubinfeld and Joe Cecil discuss the core challenge that scientific evidence often poses for judges and juries: namely, difficulties in understanding which side to believe when the parties' experts present conflicting scientific testimony and the triers, unschooled in the science, have in their prior knowledge little basis for preferring one side's analysis to the other's. The authors review three methods the law has developed to help courts better evaluate science: court appointed experts, court appointed advisors, and special masters. Court appointed experts, like the parties' experts, evaluate the relevant evidence and may testify in court, subject to cross-examination. Their apparent neutrality is thought to make their views particularly influential if they testify, which in turn means that their findings may stimulate settlements rather than be a precursor to testimony. Court appointed experts may also contribute without rendering opinions by, for example, getting the parties to agree on a common data set or on the methods to be used in their analyses. Court appointed science advisors serve a function much like a judge's law clerks, except they assist the judge in evaluating the scientific evidence in the case while the ordinary law clerk assists by assembling relevant legal materials and aiding in opinion writing. Special masters fill a judge-like role. They can hear evidence, sort through material, help with discovery, and issue recommended findings for a judge to consider. Where a case turns on scientific evidence, they can be chosen for their expertise in the relevant science.

None of these procedures is in common use, and although they are attractive options, they also have, as Rubinfeld and Cecil point out, potential shortcomings. These include the extra costs they impose on parties and the possibility that they may have undue influence on final results, particularly if the science is not settled. Experts may be unbiased in their relationship to the parties, but they may favor or deplore particular scientific methods or schools of thought.

Valerie Hans and Michael Saks begin their essay by noting the fundamental paradox that motivates several of the essays: "those with the power and duty to evaluate expert testimony possess less knowledge of the specialized subject matter at issue than that possessed by the experts whose testimony they are evaluating." Moreover, "Expert evidence must be prescreened for nonexpert jurors by nonexpert judges." If this is not trouble enough for the legal system, Hans and Saks point to general shortcomings of human reasoning, including the degree to which rationality may be subverted by biases relating to how information is acquired and the use of heuristics. Yet the Hans and Saks essay is more optimistic than pessimistic about the capacity of judges and juries to deal with expert scientific evidence. They point to the importance of factfinder neutrality in evaluating conflicting expert claims and to the ways in which the organization of trials and collective decision-making work to foster careful processing of information.

Perhaps most striking in the Hans and Saks essay is the number of studies they can reference that provide an empirical basis for procedures and reforms that are likely to enhance the capacity of jurors and judges to understand and rationally eval-

uate the claims experts make. Also striking is how few of the studies have been replicated to create a robust body of research, allowing an observer to say with confidence, "this will work" rather than "this appears promising." Their conclusion, thus, is hard to dispute: "We must collect data and run experiments; that is, we should take a scientific approach to deciding on those reforms that will best enable judges and juries to cope with modern scientific evidence."

In their closing essay, David Baltimore, Judge David S. Tatel, and Anne-Marie Mazza highlight the challenges posed by the distinct cultures of science and the law and discuss one of the most important recent developments in efforts to bridge gaps between these cultures: the creation of new, broadly representative institutions that bring members of both cultures together to work cooperatively on issues that are raised at their intersection. Baltimore and Judge Tatel currently cochair one of the most important manifestations of this effort: the Committee on Science, Technology, and Law (CSTL), a new standing committee that serves under the auspices of the National Academies of Sciences, Engineering, and Medicine. In their essay, Baltimore, Tatel, and Mazza describe the concerns that inspired the creation of the CSTL and the legal backdrop that helped stoke these concerns. They then highlight some of the CSTL's accomplishments, including its influence on rule-making and public policy and the establishment, under its auspices, of a committee that took a hard look at the scientific foundations of the different forensic sciences, an effort yielding a critical report that sparked an ongoing national conversation about the forensic sciences, affecting both the legal and scientific communities. Other efforts have been similarly well received. Together with ongoing research, bringing experts of this sort together has an important role to play in improving the quality of the science offered to courts and the ability of courts to intelligently evaluate that science.

As editors of this volume, we are delighted by the range of new and thoughtful insights about the relationship between science and the legal system represented by the essays in this collection. The authors do not provide solutions to all of the challenges presented by the interface between science and the legal system. The gaps, pushbacks, and procedural obstacles will continue to require attention, borrowing from Mnookin's characterization, to fill the science-law glass. They do, however, provide reasons for optimism about future collaboration between science and law.

AUTHOR BIOGRAPHIES

SHARI SEIDMAN DIAMOND, a Fellow of the American Academy since 2012, is the Howard J. Trienens Professor of Law and Professor of Psychology at the Northwestern University Pritzker School of Law, and Research Professor at the American Bar Foundation. She is the author of the *Reference Guide on Survey Research* in the *Reference Manual on Scientific Evidence* (3rd ed., 2011) and *The Multiple Dimensions of Trial by Jury: Studies of Jury Behavior* (2016, in Spanish) and editor of *Trademark and Deceptive Advertising Surveys: Law, Science, and Design* (with Jerre B. Swann, 2012).

RICHARD O. LEMPERT, a Fellow of the American Academy since 1993, is the Eric Stein Distinguished University Professor of Law and Sociology, emeritus, at the University of Michigan. He is the author of *A Modern Approach to Evidence: Text, Problems, Transcripts, and Cases* (with Samuel Gross et al., 5th ed., 2013) and *An Invitation to Law and Social Science* (with Joe Sanders, 1986) and editor of *Evidence Stories* (2006).

[1] Tal Golan, *Laws of Men and Laws of Nature: The History of Scientific Expert Testimony in England and America* (Cambridge, Mass.: Harvard University Press, 2004), 20.

[2] *Alsop v. Bowtrell* (1619) Cro. Jac. 541; 79 ER.

[3] Carol A. G. Jones, *Expert Witnesses: Science, Medicine, and the Practice of Law* (Oxford: Oxford University Press, 1994), 20.

[4] Golan, *Laws of Men and Laws of Nature* [see note 1], 49.

Science, Common Sense & Judicial Power in U.S. Courts

Sheila Jasanoff

Abstract: Courts routinely resolve factual disputes as an adjunct to settling legal controversies, and such fact-finding frequently involves scientific and technical evidence. It is important to ask what intellectual resources judges bring to this task. Instead of assessing how much science judges know or understand, this essay focuses on the judge's role in articulating and reinforcing prevailing cultural attitudes toward science. Background judicial assumptions matter at three significant junctures. First, judges maintain the lay-expert boundary by deciding whether an issue demands expert testimony at all. Second, judges act as epistemological gatekeepers, by determining which expert claims and ways of reasoning are entitled to deference and which are not. Third, judges decide how to classify and categorize things of uncertain ontological status as a prelude to applying legal rules. Each kind of decision offers a window into judicial common sense, a relatively neglected topic in studies of law and science.

SHEILA JASANOFF is the Pforzheimer Professor of Science and Technology Studies at Harvard University. She is the author of *The Ethics of Invention* (2016), *Science and Public Reason* (2012), and *Designs on Nature: Science and Democracy in Europe and the United States* (2005).

The courtroom is a space of reenactment. Something happened in the world to awaken society's demand for moral reckoning: someone must be blamed, someone punished, someone rewarded for exceptional enterprise, someone, if possible, made whole. Whether the event was a deadly assault or the misappropriation of private funds through an elaborate Ponzi scheme or a scientific discovery giving rise to intellectual property claims, the legal process offers an opportunity to replay the sequence of events before an authority capable of making binding judgments that satisfy our collective sense of order, compassion, or moral indignation. Such weighty decisions demand a full-blown commitment to factual truth, for without a baseline of agreed upon facts, no judgment could satisfy the world's demands for justice.

Courts can be seen in this sense as sites of translation. What happened back there and then must be replayed as accurately as possible here and now before an empowered moral adjudicator, a judge,

© 2018 by the American Academy of Arts & Sciences
doi:10.1162/DAED_a_00517

usually supported in U.S. lower courts by a fact-finding jury. Like a pointillist painting decomposed into its individual dots and pixels of paint, each moment, each unit of action from the bygone event must be brought into the adjudicatory setting, physically or verbally, in a form sufficiently reliable to render moral evaluation both possible and plausible. Each element, then, must be transported before the eyes of the adjudicator in trustworthy form, a form recognizably related to the reality of the circumstances in question. No wonder, then, that a murder trial can consume months of preparatory time, a corporate financial scandal can take years to unravel, and a regulatory or patent controversy can take seven years or more to journey to the Supreme Court. No wonder, too, that the rules of translation by which the external drama is brought in and reenacted in contexts of adjudication have attracted so much attention from legal analysts.

Scientific evidence presents special problems of translation. First, science itself is already a form of translation: it is a means of making the facts of nature knowable in human terms, through instrumental measurements, visual or quantitative representations, and specialist discourses that enable followers to build on findings that have gone before. Second, when serving the purposes of the law, science and its associated technologies offer an especially powerful means for bridging time and space, as warranted truth-telling mechanisms that can, when properly used and interpreted, bypass distortions produced by human memory or motives. Yet science cannot speak for itself to a legal factfinder. Science's gaze on matters in dispute is always at a remove, transmitted through intermediaries, both human and nonhuman, that stand in for what actually *is*. When scientific evidence is introduced in court, there is thus a double challenge: the presentation must close the gap between the original action and its courtroom replication (for example, by establishing a chain of custody for physical samples) and it must persuade the court that science's findings relate truthfully and reliably to the events, actions, intentions, and consequences that are the subject matter of adjudication.

The primary social innovation through which the law has sought to accommodate science is the figure of the expert witness. Rule 702 of the Federal Rules of Evidence provides that a person qualified by "knowledge, skill, experience, training, or education" can offer specialized testimony to facilitate a court's determination of scientific or technical facts. The expert testifies to the authenticity and meaning of the traces left by the questioned actions, thereby bridging the gap between the unrecorded past and its present reenactment. This performance entails a second-order problem that has preoccupied the law for more than two hundred years.[1] How can the legal factfinder be sure that the expert is offering dependable testimony and not unsubstantiated personal opinion or, worse, false, fraudulent, or misleading views clothed in the authority of expertise?

In this essay, I focus not on the reliability of expertise, but on the judge's role in articulating and reinforcing prevailing cultural attitudes toward science. This topic has received relatively little attention from legal practitioners and scholarly commentators. Yet judicial thinking is of paramount importance in three ways. First, judges consider and ratify how scientific and legal authority should work vis-à-vis each other, for instance by determining whether an issue does or does not demand expert testimony. Second, judges play the part of epistemological gatekeepers. The judge's eye determines which expert claims are entitled to consideration in the courtroom, or not, thereby privileging certain ways of knowing above others. Third, and perhaps least visibly, judges exercise ontolog-

ical power by deciding how to classify and categorize things for purposes of legal decision-making.

In making all three sets of moves, courts operate to some extent as amplifiers of common sense, importing widely held cultural ideas about how things work into their assessments of both the necessity for and the reliability of scientific and technical expertise. Though tacit and informal, such judgments are neither wholly subjective nor arbitrary. They are rooted in engrained collective beliefs, a common sense that has power precisely because it operates below the level of conscious argument, in a register of cultural familiarity, and hence is not open to questioning, indeed is accepted as integral to law.

In an influential essay, the anthropologist Clifford Geertz urged his fellow cultural analysts to view common sense as an ordered system of thought, on a par with more formal systems such as "physics, or Islam, or law, or music, or socialism."[2] Common sense, in Geertz's telling, fills in the gaps of experience, when conventional explanations and classifications fail, and it does so in ways that are culturally intelligible, widely shared, and hence unquestioned by members of a given society. Boundary-crossing anomalies, Geertz suggested, are treated differently in different cultures. Intersexuality, to take one example, is known in all human societies, but it is variously classified as horror, wonder, or simple biological error because different shared assumptions about the nature of sexuality condition responses to the apparent anomaly of not being either simply male or simply female. Geertz concluded that, "Common sense is not what the mind cleared of cant spontaneously apprehends; it is what the mind filled with presuppositions . . . concludes."[3] Through an analysis of significant Supreme Court decisions, this essay probes the presuppositions about science and technology, and their uses as evidence, that fill the minds of the federal judiciary.

What qualifies an expert's testimony as good enough to count as pertinent evidence? The U.S. Supreme Court wrestled with this question in three landmark evidence decisions of the 1990s, beginning in 1993 with *Daubert v. Merrell Dow Pharmaceuticals, Inc.*[4] In that first and still most significant decision, the Court held that the earlier rule for the admissibility of scientific evidence in federal proceedings, derived from a 1923 appellate decision in a murder trial, *Frye v. United States*, had been superseded by the Federal Rules of Evidence.[5] The *Frye* standard turned on whether a novel scientific procedure enjoyed general acceptance in the relevant scientific community. The Federal Rules of Evidence, as interpreted in *Daubert*, did not endorse this one factor test.[6] More pointedly, the Court reminded judges that they were responsible for acting as gatekeepers with respect to proffered expert testimony and offered guidance on what that meant. Judges should think like scientists in assessing the relevance and reliability of scientific evidence, using the same criteria that scientists would apply. While cautioning against treating them as a "checklist," the Court named four criteria that instantly became, to some degree, canonical: is the claim falsifiable and has it been tested; was it peer reviewed; has an error rate been determined; and has the underlying science won general acceptance?

Following *Daubert*, the judge's understanding of what science is, how it works, and what constitutes legitimate expert representations of scientific knowledge became a decisive influence on determinations of admissibility. What, though, did this shift mean in terms of "law's knowledge"?[7] Did science's ways of knowing indeed displace traditional modes of judicial reasoning, or was some more complex al-

chemy at work in the translation exercise that *Daubert* so radically reconfigured? Did particular traits of judicial epistemology, particular styles of reasoning, or ways of assessing the facts of the world gain power and influence in the post-*Daubert* adjudicatory environment? *Kumho Tire v. Carmichael*, the last of the *Daubert* trilogy, offers particular illumination.[8]

On July 6, 1993, Patrick Carmichael, one of the plaintiffs in *Kumho*, was driving a minivan when the right rear tire blew out, killing one passenger and severely injuring several others. The plaintiffs claimed that the blowout was due to a defect in the design or manufacture of the failed steel-belted radial tire. Their case rested to a significant degree on the testimony of Dennis Carlson Jr., a mechanical engineer and professed expert in tire failure analysis, who offered his informed opinion that the blowout was not caused by ordinary wear or misuse, but rather by a design defect.

Through visual and tactile inspection, Carlson concluded that a manufacturing defect had caused the tread to separate from the body, or "carcass," of the tire, despite evidence that the tire was seriously worn and had been inadequately repaired for punctures on two occasions.[9] The district court mechanically applied the four *Daubert* criteria to Carlson's evidence and found it inadmissible. The Eleventh Circuit Court of Appeals reversed on the ground that the *Daubert* standard applied only to scientific, not technical, evidence, and the Supreme Court, under Chief Justice Rehnquist, agreed to review that decision. The questions before the Court were whether *Daubert*'s gatekeeping criteria applied only to scientific evidence or also to technical and other nonscientific expert evidence; and, if so, whether the four *Daubert* criteria could be used to assess reliability in this case. The Court ruled positively on both counts, reversing the Eleventh Circuit ruling.

In the original trial and first appeal, Dennis Carlson's legitimacy as an expert had not been in question. But it was not obvious to the courts what kind of expert he was and, consequently, whether his kind of knowledge could be held to the *Daubert* standard for scientific expertise. Judge Stanley Birch, writing for the Eleventh Circuit, ruled that this determination was crucial. "In short," Birch concluded, "a scientific expert is an expert who relies on the application of scientific principles, rather than on skill- or experience-based observation, for the basis of his opinion."[10] Citing a Sixth Circuit decision to support this distinction, Birch revisited that court's analogy, in which a hypothetical jury needs an explanation of a bumblebee's ability to fly.[11] You might bring in an aeronautical engineer, the Sixth Circuit mused, to explain general principles of flight that could be applied to the bee. Even if such an expert had never seen a bumblebee, the testimony could still be admitted as relevant evidence. On the other hand, the testimony of a beekeeper with no scientific training could also plausibly tell the jury, on the basis of firsthand observations, that bumblebees always take off into the wind. "In other words," the Sixth Circuit concluded, "the beekeeper does not know any more about flight principles than the jurors, but he has seen a lot more bumblebees than they have."[12] Here, the beekeeper's experience is seen as different in degree, but not in kind, from that of a juror, and is entitled to be heard for that very reason: the beekeeper knows relevant facts better than any juror. This is not so for the aeronautical engineer, who knows nothing about bees in particular and hence must draw on certified theoretical knowledge for authority.

Carlson, by this reckoning, presented a conundrum. With formal degrees in mechanical engineering *and* ten years of experience in tire testing at Michelin, Carlson offered testimony that was hard to classify in terms of the beekeeping analogy.

Judge Birch wondered, "is the testimony at issue in this case more like that of a beekeeper applying his experience with bees or that of an aeronautical engineer applying his more generalized knowledge of the scientific principles of flight?"[13] Despite Carlson's engineering qualifications, Birch concluded that he was, in terms of the issue at hand, a beekeeper of tire failures: "Like a beekeeper who claims to have learned through years of observation that his charges always take flight into the wind, Carlson maintains that his experiences in analyzing tires have taught him what 'bead grooves' and 'sidewall deterioration' indicated as to the cause of the tire's failure."[14] Ergo, Birch reasoned, Carlson's testimony fell outside of *Daubert*'s scope – in the realm of experience rather than science – and the district court therefore erred in applying the *Daubert* criteria and ruling his evidence inadmissible.

The Eleventh Circuit's attempt to draw a bright line between science and nonscience flies in the face of much historical work in science and technology studies showing that, in the conduct of science, there is no essential distinction between theory and practice, or "head" and "hand" in the terminology of historian Steven Shapin and sociologist Barry Barnes.[15] Such demarcations are culturally produced and pedagogically transmitted rather than intrinsic to the scientific enterprise. The Supreme Court did not cite such insights, but came to similar conclusions from different assumptions about how to articulate a sensible demarcation between science and nonscience.

During oral argument, Chief Justice William H. Rehnquist signaled his discomfort with any categorical distinction between science and expertise. "All right," he summed up with more conviction than elegance, "and then you'd also agree that there isn't a rigid categorization as between science or not where you could say the *Daubert* test is or is not useful. The answer is both within and outside something that the Harvard University would call science or something. I mean, sometimes within that, sometimes outside of it . . . *Daubert*'s helpful, sometimes it's not helpful."[16]

Crucially, Rehnquist indicated that it is the judge who decides on a case-by-case basis when *Daubert* is "helpful" and when it is not – not "the Harvard University" nor the academic scientific establishment. This point was brought home by Judge Jed S. Rakoff during the discussions leading to this issue of *Dædalus*. He noted that judges routinely make distinctions among *Daubert*'s four criteria based on their preconceived understandings of what is or is not germane to doing good science:

> I think this error rate one is often not considered a requirement. There are many kinds of science that – they don't have a known error rate, and I think *many judges will accept* that that's not dispositive. . . . But with respect to whether it's been tested or not, most judges seem to believe that, "God, if it isn't – hasn't been tested, how could it be called science?" So, yeah, that one is taken as a sine qua non. Has it been peer reviewed and the subject of publication? Well, if it hasn't been that, then it's just someone's . . . idea – that we have no idea whether it's ever been put to the test, and *the test there is very similar to the legal tests of cross examination*. So *it comes naturally to judges* to say, "If it hasn't been peer reviewed and publicized, that's . . . pretty damning." The error rate, different – I don't think more judges regard that as a sine qua non, *and then the fourth is, of course, the old-fashioned Frye test*, whether it's generally accepted, and the question, always, there is what's the relevant group.[17]

The passage as a whole illustrates the commonsensical mindset with which judges decide how to apply *Daubert*, a process that foregrounds longstanding judicial intuitions about what makes any claim stronger or weaker than another. Particu-

larly noteworthy in this text is the equating of peer review with cross-examination, a method of adversarial questioning deeply familiar to judges and one long seen as capable of separating the wheat of truth from the chaff of false pretenses.

Later in the *Kumho* oral argument, Rehnquist clarified his position regarding expert evidence: namely, that inductive arguments are insufficient unless they are, in effect, theory-laden.

> [I]n my mind, anyway, I think the hardest question for you would be, you'd say, well, look, there is a theory going on here that in the absence of these four specific factors, not any kind of abuse but four kinds, beading, flange, whitewall discoloration, and some other thing, that your expert seems to say, in the absence of those four things, it must have been defect.
>
> And immediately *a common sense person thinks*, what? You mean nails couldn't be an abuse? You mean, it's bald couldn't be an abuse?
>
> And the expert says – if the expert then says, well, I have a lot of experience at this, you say, wait a minute. You couldn't have seen hundreds or thousands of tires that have had two nails – you know, two nails driven into them, and they're bald, and they've gone 100,000 . . . that's impossible.
>
> You're going on some theory, and if you're going on some theory, you tell me who else believes that theory.[18]

Implicit in Justice Rehnquist's thinking, as in Judge Birch's, is the idea of the putative "common sense person" as an expert on things-in-the-world, and a person whom the judge is entitled to represent when elucidating such everyday understandings. In his spontaneous dramatization of expertise encountering lay skepticism, the Chief Justice in effect tests the limits of the expert's reasoning, as well as the improbable certainty of his experience-based claims, by constructing alternative, common-sense scenarios that display the gaps between Carlson's observations and the conclusion drawn from them. To support a claim on the basis of experiential knowledge, Rehnquist's imagined interlocutor insists, the expert must be "going on some theory," because only such a theory could rule out all other intervening causal stories (such as the nails or the baldness); and then the expert had better be able to marshal the resources of a like-minded community ("you tell me who else believes that theory"). If such support is not forthcoming, Rehnquist implies, then that expert's gaze is no more reliable than anyone else's.

Behind Rehnquist's questioning is classic Humean skepticism, an assumption that a finite number of observations of other tires could not possibly provide a firm basis for conclusions regarding the one that failed. The only legitimate foundation for so particular a claim must be a general theory, and here Rehnquist reverts back to the familiar comfort of the *Frye* rule. If there is an applicable theory, then others should also believe in it; in other words, it should be generally accepted.

In deciding *Kumho*, the Court unanimously agreed that no *a priori* boundary between science and engineering or other forms of expertise was practically workable: "Finally, it would prove difficult, if not impossible, for judges to administer evidentiary rules under which a gatekeeping obligation depended upon a distinction between 'scientific' knowledge and 'technical' or 'other specialized' knowledge. There is no clear line that divides the one from the others."[19] Illustrating a judicial predilection for citing legal authority even for matters of epistemic principle, the Court turned to the great common law jurist Learned Hand for the proposition that experts may come to their conclusions through the use of "general truths derived from . . . specialized experience."[20]

But it was in part three of the opinion, authored by Justice Stephen Breyer, that the majority most clearly articulated its epistemological sensibilities. Ostensibly instructing the trial court on how it could reasonably have applied the *Daubert* criteria to Carlson's testimony, Justice Breyer never mentioned the four tests. He instead conducted, in effect, his own virtual inspection of the contested tire; significantly, the opinion even included a picture from a manual on how to buy and care for tires. The conclusions reached by the tire expert's eye fell short in the light of the judge's (presumably more rigorous) reexamination of the evidence:

> The [trial] court could reasonably have wondered about the reliability of a method of visual and tactile inspection sufficiently precise to ascertain with some certainty the abuse-related significance of minute shoulder/center relative tread wear differences, but insufficiently precise to tell "with any certainty" from the tread wear whether a tire had traveled less than 10,000 or more than 50,000 miles.[21]

We see here the law's age-old reliance on direct eye-witnessing as the means through which events are most reliably reconstructed in the courtroom – but with a twist.[22] Carlson's spurious precision failed to meet the common-sense standard of "intellectual rigor" that Justice Breyer and his coauthors deemed necessary to rule out alternative causes.

The *Daubert* trilogy tilted epistemic authority subtly but surely in favor of how judges see and know the world, including how they imagine science itself, when they are prepared to substitute their own authority for that of an expert witness, and how they classify the products of science and technology. These judgments are pervasive, cutting across many domains of law that are not normally seen as ripe for epistemic analysis; for example, environmental law, intellectual property law, and constitutional law. Yet in high-profile cases in all these areas, the ultimate legal judgment has turned on how the courts, including especially the Supreme Court, analyze the things that science and technology introduce into the world. Once again, these are decisions in which judicial common sense governs, though the foundations of such intuitions are seldom questioned or laid bare for critical inquiry. Examples from recent case law illustrate these points.

Environmental law. Few areas of modern law rely as much on the scientific assessment of causes as environmental regulation and the repeated challenges against it. Causes and consequences are difficult to establish with any certainty. It is clear from the long record of environmental litigation that repose on technical issues ultimately results less from agreements about what is true than from parties' acceptance that scientific assessment procedures were properly followed, including those for soliciting expert advice and subjecting it to the scrutiny required by applicable statutory mandates.

Environmental law runs into special difficulties when regulatory action is directed toward previously unrecognized hazards. In these cases, the regulator often confronts an entity or agent that was either not known at all (such as small particulate matter deemed since the late 1990s to be substantially responsible for urban respiratory disease), or is shown to have unsuspected properties that make it no longer suitable for its original purposes (for example, lead as antiknock agent, DDT as insecticide, thalidomide as anti–morning sickness drug, or atrazine as weed killer). In such cases, questions about the science become interlaced with politics. Huge stakes may hang on whether a product crosses the line from safe to dangerous or, indeed, is recognized at all as a potential regulatory target.

The long-running U.S. debate on climate change illustrates how environmental science is vulnerable to concerted attack when new, scientifically certified objects and phenomena threaten settled lifestyles. The first two decades of the twenty-first century saw repeated reversals in federal policy based on the political alliances of the administration in power, particularly along the dividing line between fossil fuels and renewable energy. For the most part, these conflicts played out at the level of science and regulatory policy at the Environmental Protection Agency (EPA), but they spilled into courts in one landmark case, *Massachusetts v. EPA*, which also serves as a kind of instruction manual on how judges negotiate the competing claims of science and law in rendering the facts of nature tractable for moral adjudication.[23]

In this case, the majority deferred to science, as the EPA also had, in accepting "the existence of a causal connection between man-made greenhouse gas emissions and global warming." But unlike the EPA, the Court also concluded that the language of the Clean Air Act was expansive enough to admit new entities like greenhouse gases into the definition of "air pollution": "While the Congresses that drafted §202(a)(1) might not have appreciated the possibility that burning fossil fuels could lead to global warming, they did understand that without regulatory flexibility, changing circumstances and scientific developments would soon render the Clean Air Act obsolete. The broad language of §202(a)(1) reflects an intentional effort to confer the flexibility necessary to forestall such obsolescence."[24] Resolving the definitional question also resolved the issue of the EPA's authority to act: "Because greenhouse gases fit well within the Clean Air Act's capacious definition of 'air pollutant,' we hold that EPA has the statutory authority to regulate the emission of such gases from new motor vehicles."

Justice Antonin Scalia, in a sharply worded dissent, disagreed with the majority's construction of the act and urged a more prosaic reading of the term "air pollutant." He found less certainty in the science than his colleagues did, but just as importantly, he concluded that the EPA had rightfully interpreted the words of the Clean Air Act as not requiring the regulation of greenhouse gases. Scalia's turn to common sense took the form of insisting that the language of the law be given its plain meaning:

> We need look no further than the dictionary for confirmation that this interpretation of "air pollution" is eminently reasonable. The definition of "pollute," of course, is "[t]o make or render impure or unclean." Webster's New International Dictionary 1910 (2d ed. 1949). And the first three definitions of "air" are as follows: (1) "[t]he invisible, odorless, and tasteless mixture of gases which surrounds the earth"; (2) "[t]he body of the earth's atmosphere; esp., the part of it near the earth, as distinguished from the upper rarefied part"; (3) "[a] portion of air or of the air considered with respect to physical characteristics or as affecting the senses." *Id.*, at 54. EPA's conception of "air pollution" – focusing on impurities in the "ambient air" "at ground level or near the surface of the earth" – is perfectly consistent with *the natural meaning of that term*.[25]

Faced with the ontological problem of slotting a new physical entity – "greenhouse gases" – into a preexisting statutory framework, the justices divided in their conclusions, but each position rested on the author's own tacit sense of how the law-science relationship should properly work. For the majority, it made sense that science declares the state of how things are, and it is only natural to interpret broad legal language to accommodate changes in our understanding of the world. For Justice Scalia, a strong advocate for the sovereignty of the legal text, it was just as nat-

ural (or commonsensical) to insist that words, first of all, be given their ordinary meaning.[26] If those "natural" meanings reasonably supported the agency's decision not to recognize a new regulatory object, then no amount of scientific urgency could undermine that judgment. The remedy, if any, would have to come from the legislature that wrote the law, the only body entitled to change the words to permit a new reading.

Intellectual property law. Ontological judgments are the basic stuff of intellectual property decisions, since at the core of most awards or denials of such rights are determinations whether something new (or, in the case of copyright, original) has been created and, if so, whether it is the kind of thing for which the award of such rights was meant. In the case of patents, both judgments reveal tacit judicial understandings of what inventiveness means and where the boundary lies between nature and human artifice, along with beliefs about the right relationship between scientific and legal innovation.

Thus, in *Diamond v. Chakrabarty*, the landmark 1980 decision in which a divided Supreme Court held that human-made living organisms are no different from nonliving ones for purposes of patenting, Chief Justice Warren Burger's opinion cast the law's role as essentially passive.[27] Like the majority opinion in *Massachusetts v. EPA* almost thirty years later, *Chakrabarty* construed the governing law as expansive enough to accommodate changes in science. Congress, the Court famously held, "plainly contemplated that the patent laws would be given wide scope," so that patents could be granted for "anything under the sun that is made by man." At the same time, the Court positioned itself as powerless to change the course of scientific or technological progress: "legislative or judicial fiat as to patentability will not deter the scientific mind from probing into the unknown any more than Canute could command the tides."[28] This was a remarkable bit of rhetorical jiujitsu in a decision widely regarded as having enabled the modern biotechnology industry to come into being, and it was justified in part by invoking a trope of demonstration through ordinary empirical witnessing: the king at the shore powerless to hold back the sea from advancing.

The importance to courts of the notion of plain, unobstructed seeing shines through in another patent decision overturning years of settled legal practice: the Supreme Court's 2013 decision in the Myriad Genetics case, ruling that human genes are not patentable.[29] Here, in a case challenging patents that Myriad held on human breast cancer genes, the Justice Department and the American Civil Liberties Union (ACLU) presented the Court with metaphors that would make plain why only one conclusion was reasonable. The genes that Myriad had isolated, petitioners claimed, could be seen by anyone who cared to look; it took no special inventiveness to discern them. To make this argument stick, the Justice Department invented a hypothetical instrument – the "magic microscope" – arguing: "[I]f an imaginary microscope could focus in on the claimed DNA molecule as it exists in the human body, the claim covers ineligible subject matter."[30] Chris Hansen, lead lawyer for the ACLU, opted in oral argument for a still more elemental metaphor: gold, with its connotations of extraction and mining. Finding a method of extracting gold, Hansen said, might entitle one to a patent, as would finding a new use, such as "a new way of using gold to make earrings."[31] But the gold itself would not be patentable and neither are genes extracted from the human body.

Unlike the reference to King Canute in *Chakrabarty*, which echoed an *amicus* brief by the biotechnology company Genentech, neither the magic microscope nor the gold

analogy survived into the Court's gene patenting decision. The moves that ACLU attorney Hansen made to classify genes as products of nature did, however, resonate. With the same matter-of-factness conveyed in the ACLU's oral argument, the Court ruled that "Myriad did not create anything. To be sure, it found an important and useful gene, but separating that gene from its surrounding genetic material is not an act of invention."[32] If nature was the initial inventor, then no amount of brilliance, effort, or innovation could render nature's work patentable. Put differently, the Court concluded: "discovery, by itself, does not render the BRCA genes 'new…composition[s] of matter,' §101, that are patent eligible."[33] And the key to distinguishing between invention and discovery remained the act of seeing: anyone, after all, could see that the "location and order of the nucleotides [in an isolated gene] existed in nature before Myriad found them."[34] By contrast, synthetic complementary DNA (cDNA) could be patented because it is made up of a nucleotide sequence that does not visibly exist within the body.

Constitutional law. In an era in which human lives are ever more intimately entwined with the products of science and technology, ontological judgments have begun to figure with increasing frequency in constitutional decision-making. Back in 1967, in what now feels almost like ancient history, the Supreme Court decided 7 to 1 in *Katz v. United States* that a warrantless wiretap violates the Fourth Amendment.[35] A physical intrusion was not deemed necessary for constitutional purposes; it was sufficient that the defendant had sought to reserve the space as private. It was in this respect, Justice John Harlan concurred, an area where, as in a home but not in a field, "a person has a constitutionally protected reasonable expectation of privacy."[36] The telephone booth was transformed, in the eye of the Court, into an enclosed space, similar to a room, whose walls should have provided safeguards against the intrusive, if metaphorical, "presence" of the wiretapping machine.

Developments in many areas of engineering and technology (such as nanotechnology, gene editing, robotics, and artificial intelligence) are further blurring boundaries between taken-for-granted classifications that once provided clear baselines for constitutional jurisprudence. At stake are questions about the division between nature and artifice, life and death, and human and nonhuman. Is a cell line sufficiently continuous with the human body it came from to deserve some degree of special treatment, such as informed consent to being used in research?[37] What sorts of personal rights extend to "data subjects," for example, the right to be forgotten?[38] What would it mean for robots to be classified as "electronic persons," with explicit rights and obligations? Questions such as these are bound to proliferate in coming decades, focusing renewed attention on the intellectual resources with which courts approach these novel tasks of boundary drawing.

Such issues are already being addressed by U.S. high courts. An instructive example is the Supreme Court's 2014 decision in *Riley v. California*, holding that the Fourth Amendment protects against warrantless searches of cell phones.[39] While this decision can be seen as a principled extension of earlier decisions such as *Katz*, Chief Justice John Roberts's reasoning displays a more interesting dynamic. Roberts did not rest his opinion so much on a theory of the kinds of spaces in which people should feel secure as on the kinds of subjects we have become in the digital age: in effect, cyborgs. Cell phones, he noted, stand in for many different kinds of recording and storage technologies that register information about private lives: "They could just as easily be called cameras, video players, rolodexes, calendars, tape recorders, li-

braries, diaries, albums, televisions, maps, or newspapers." As such, they are de facto extensions of human selves. Indeed, as the Chief Justice mused, cell phones are "now such a pervasive and insistent part of daily life that the proverbial visitor from Mars might conclude they were an important feature of human anatomy."[40]

It is perhaps not surprising that a judge trained in the common law's style of empirical reasoning imagined a Martian who, like its human counterpart, would focus in the first instance on the visible connections between the cell phone and the human anatomy. Yet the decision turned on a more subtle difference between the cell phone and any other device a person might be carrying. It was the capacity of the phone to provide entry into a person's consciousness – by revealing contacts, photographs, e-mail, telephone data, Internet search records – that was at stake in the ruling. The material object, in other words, makes the normally locked and protected spaces of the human mind visible to prying eyes. To claim a cell phone is "materially indistinguishable" from any other physical object was, Roberts therefore concluded, "like saying a ride on horseback is materially indistinguishable from a flight to the moon."

Looking across the broad terrain of legal encounters with science and technology, it is hard to ignore the extent to which judges in the U.S. legal system have become transmitters of cultural common sense, particularly in their views on the right ways to integrate scientific knowledge and technical expertise into the fabric of the law. Even in those areas where the law explicitly defers to science, as in *Daubert*'s injunction to judges to think like scientists, we find that deference is filtered through preexisting judicial ideas that shape choices at crucial junctures: how the law should accommodate changes in science; who counts as an authoritative expert; and how new objects should be classified for purposes of applying established legal rules.

Despite *Daubert*'s supposedly revolutionary impact on the admissibility of evidence, a close look at *Kumho* shows how quickly judicial common sense reasserted itself, consolidating even greater power over a wider range of knowledge in the hands of the judge. Deeply enmeshed within that expansion of power was an epistemic tilt toward the credibility of the eyewitness above the abstracted, probabilistic knowledge of the witness who appeals to scientific theory. Under the guise of better science in the courtroom and more rigorous assessment of scientific evidence, the law thus reasserted its ancient sources of authority: case-by-case reasoning and the fundamental role of direct eyewitnessing, nominally guided by the *Daubert* criteria as a stronger armature for older forms of judicial empiricism.

Common sense in its nature is unreflective. In Geertz's terms, it steps in as "what everybody knows" and is readily accepted for that very reason. Judicial common sense is no exception: yet there has been little systematic inquiry into how judges think about science and technology, let alone into the consequences of buying into particular theories of the scientific method or technological change. Common sense ensures a kind of stability in the workings of society, and its role in legal reasoning may, in that respect, serve a valuable function as an affirmation of important communal norms and a safeguard against overly rapid and arbitrary turns of the wheel. Yet when federal judges serve society over many decades, one may ask whether such lack of self-awareness in the law is an unmitigated public good. More than having judges think like scientists, both the judiciary and society would benefit from deeper reflection on what it means – in societies transformed by scientific and technological change – to think like judges about science, evidence, and invention.

AUTHOR'S NOTE

This essay draws on research conducted under a grant from the National Science Foundation (Award No. 0850962). I would like to thank Ellen Bales for significant background research on the Supreme Court's evidence decisions and collaboration on a working paper that served as a partial basis for this essay.

ENDNOTES

[1] Tal Golan, *Laws of Men and Laws of Nature: The History of Scientific Expert Testimony in England and America* (Cambridge, Mass.: Harvard University Press, 2004).

[2] Clifford Geertz, "Common Sense as a Cultural System," *The Antioch Review* 33 (1) (1975): 788.

[3] Ibid., 781.

[4] *Daubert v. Merrell Dow Pharmaceuticals, Inc.*, 509 U.S. 579 (1993).

[5] *Frye v. United States*, 293 F. 1013 (D.C. Cir. 1923).

[6] As elaborated in *Daubert*, the Rules require a trial court to take into account a number of considerations, with special attention to the ones mentioned below, that might affect the reliability of expert scientific evidence.

[7] Sheila Jasanoff, "Law's Knowledge: Science for Justice in Legal Settings," *American Journal of Public Health* 95 (S1) (2005): S49 – S58.

[8] *Kumho Tire Company, Ltd., et al. v. Patrick Carmichael et al.*, 526 U.S. 137 (1999).

[9] See also Sheila Jasanoff, "Science and the Statistical Victim: Modernizing Knowledge in Breast Implant Litigation," *Social Studies of Science* 32 (1) (2002): 37 – 69.

[10] *Patrick Carmichael et al. v. Samyang Tire, Inc., et al.*, 131 F.3d 1433, 1435 (11th Cir. 1997).

[11] *Berry v. City of Detroit*, 25 F.3d 1342 (6th Cir.1994).

[12] Ibid., 1350, quoting *Patrick Carmichael et al. v. Samyang Tire, Inc., et al.*, 131 F.3d, 1435 – 1436.

[13] *Patrick Carmichael et al. v. Samyang Tire, Inc., et al.*, 131 F.3d 1435 (11th Cir. 1997).

[14] Ibid.

[15] Steven Shapin and Barry Barnes, "Head and Hand: Rhetorical Resources in British Pedagogical Writing, 1770 – 1850," *Oxford Review of Education* 2 (3) (1976): 231 – 254.

[16] Oral Arguments, *Kumho Tire Company, Ltd., et al. v. Patrick Carmichael et al.*, 1998 U.S. Trans. Lexis 80, 42 – 43.

[17] Author conversation with Jed S. Rakoff, *Dædalus* Authors' Conference, Science and the Legal System, Cambridge, Massachusetts, July 20 – 21, 2017. Emphasis added.

[18] Oral Arguments, *Kumho Tire Company, Ltd., et al. v. Patrick Carmichael et al.*, 45 [see note 16]. Emphasis added.

[19] *Kumho Tire Company, Ltd., et al. v. Patrick Carmichael et al.*, 526 U.S., 148 [see note 8].

[20] Ibid.

[21] Ibid., 155.

[22] Jasanoff, "Science and the Statistical Victim," 49 [see note 9].

[23] *Massachusetts v. Environmental Protection Agency*, 549 U.S. 497 (2007).

[24] Ibid.

[25] Ibid., 559 – 560.

[26] Textualism of the kind Justice Scalia adopted in his dissent is more of a strategy of persuasion than a definitive pinning down of what a legal text really means. The meaning a judge ac-

cords to legal language is conditioned in any case by prior cultural and personal understandings of which words to question and what those words can be made to mean in context. The important point here, however, is that in resorting to the dictionary as the definitive, disambiguating authority on the meaning of the Clean Air Act, Justice Scalia sought to sidestep the majority's reliance on scientific consensus as a basis for rereading the law in new, more expansive ways. As long as common-sense dictionary definitions supported a reading that *could* justify EPA's inaction, the right recourse, in Scalia's scheme of things, would have been to return to Congress to clarify the law, focusing in this case not on the arcane details of climate science but on the plain meaning of the word "air."

27 *Diamond v. Chakrabarty*, 447 U.S. 303 (1980).

28 Ibid., 317.

29 *Association for Molecular Pathology v. Myriad Genetics, Inc.*, 569 U.S. 576 (2013).

30 *Association for Molecular Pathology v. U.S. Patent & Trademark Office*, 689 F.3d 1303, 1326 (CAFC 2012).

31 *Association for Molecular Pathology v. Myriad Genetics, Inc.*, oral argument transcript, 5, https://patentlyo.com/media/docs/2013/04/12-398-amc7.pdf (accessed July 2018).

32 *Association for Molecular Pathology v. Myriad Genetics, Inc.*, 569 U.S. 576, 591 [see note 29]. See also Chris Hansen's opening argument: "Myriad unlocked the secrets of two human genes. These are genes that correlate with an increased risk of breast or ovarian cancer. But the genes themselves, their – where they start and stop, what they do, what they are made of, and what happens when they go wrong are all decisions that were made by nature, not by Myriad. Now, Myriad deserves credit for having unlocked these secrets. Myriad does not deserve a patent for it." *Association for Molecular Pathology v. Myriad Genetics, Inc.*, oral argument transcript, 3, https://patentlyo.com/media/docs/2013/04/12-398-amc7.pdf (accessed July 2018) [see note 31].

33 *Association for Molecular Pathology v. Myriad Genetics, Inc.*, 569 U.S. 576, 591 [see note 29].

34 Ibid., 590.

35 *Katz v. United States*, 389 U.S. 347 (1967).

36 Ibid., 360.

37 Arguably, this is the principle to be extracted from the agreement reached between the National Institutes of Health (NIH) and the family of Henrietta Lacks, whose dying body was the source of the HeLa cell line, although the NIH declared the arrangement to be *sui generis* and of no precedential value.

38 Case C-131/12, *Google Spain SL v. Agencia Española de Protección de Datos* (May 13, 2014).

39 *Riley v. California*, 573 U.S. ___ (2014).

40 Ibid.

When Law Calls, Does Science Answer? A Survey of Distinguished Scientists & Engineers

Shari Seidman Diamond & Richard O. Lempert

Abstract: Sound legal decision-making frequently requires the assistance of scientists and engineers. The survey we conducted with the cooperation of the American Academy examines the views of the legal system held by some of the nation's most distinguished scientists and engineers, what motivates them to participate or to refuse to assist in lawsuits when asked, and their assessment of their experiences when they do participate. The survey reveals that a majority of the responding scientists and engineers will agree to participate when asked, and when they turn down requests, the most common reasons are lack of time and absence of relevant expertise. Dissatisfaction with legal procedures is also a deterrent, but our respondents indicated that some procedural changes would make their participation more likely. In addition, participation appears to be associated with a greater belief in the ability of the legal system to deal well with scientific matters.

SHARI SEIDMAN DIAMOND, a Fellow of the American Academy since 2012, is the Howard J. Trienens Professor of Law and Professor of Psychology at the Northwestern University Pritzker School of Law, and Research Professor at the American Bar Foundation.

RICHARD O. LEMPERT, a Fellow of the American Academy since 1993, is the Eric Stein Distinguished University Professor of Law and Sociology, emeritus, at the University of Michigan.

(Complete author biographies appear at the end of the essay.)

Sound legal decision-making increasingly depends on sound science. Yet we know remarkably little about how scientists and engineers view the legal system or what leads them to decide whether and how to interact with it. Some commentary indicates that scientists regard the legal system with suspicion and discomfort, but the supporting evidence is largely anecdotal. As a result, it is hard to gauge how deep or widespread these reactions are, and – to the extent they exist – whether they are fueled by accurate information or false impressions. Getting a better handle on relationships between scientists and the law matters because the importance of science for law cannot be disputed.

Ideally, courts and litigants would be able to call on knowledgeable, unbiased scientists and engineers whenever the fair resolution of legal disputes depended on scientific or technical information. The

© 2018 by Shari Seidman Diamond & Richard O. Lempert
doi:10.1162/DAED_a_00519

importance of the science-law relationship led us, with the cooperation of the American Academy of Arts and Sciences, to conduct a survey of the Academy's science and engineering members with the goal of providing empirical grounding for discussions about how scientists relate to law. Our survey probes scientists' views of and expert involvement with the legal system, especially as it pertains to involvement in litigation, barriers to involvement, and legal or policy changes that might make scientists more willing to aid courts and lawyers when called upon.

The legal system has long recognized the value of scientific knowledge, and lawyers and judges have sought to make use of it, even while struggling to make sense of what science has to offer. The frustration is poignantly reflected in the words of Judge Baron Hatsell in 1699, when in a homicide trial he spoke to the jury about conflicting expert testimony on the cause of death of a young woman whose body was recovered from a lake:

> The Doctors and Surgeons have talkt a great deal to this purpose, and of the waters going into the Lungs or the Thorax, but unless you have more skill in Anatomy than I, you won't be much edified by it. I acknowledge I never studied Anatomy but I perceive that the Doctors do differ in their Notions about these things.[1]

Scientists, for different reasons, have their own difficulties with how the law goes about its business. As one of our respondents put it:

> Science is about truth. The legal system is about spinning, distorting or suppressing the truth in order to win. The ethos of the two fields is fundamentally different. Even judges are biased and not objective. For these reasons, participation in the legal system is very frustrating for a scientist.

The challenge for the modern American legal system is obvious and increasing, as the frequency and complexity of encounters between science and law have multiplied with the dramatic expansion of legally relevant scientific knowledge. Courts and scientific societies have struggled with the tensions that exist.

Justice Stephen Breyer wrote in 1998 that the law "increasingly requires access to sound science."[2] Citing examples of cases on the U.S. Supreme Court's docket, he identified a range of difficult legal problems that implicated scientific, medical, and engineering questions. In lower courts too, both civil and criminal, scientific claims, along with arguments about the quality of expert testimony, are expanding features of the legal landscape. Suits for injuries from chemical exposure, for example, may require evidence on exposure effects from scientists with expertise in chemistry, biology, epidemiology, and pathology; a bridge collapse or a patent dispute may require engineering and technological expertise; and DNA evidence is often key in identifying criminals and excluding innocent individuals from prosecution. Moreover, science does not stand still. New developments in genetics, neuroscience, material sciences, and other fields are entering into legal discourse, and claims and cases are beginning to turn on them. As science has become, if anything, more important to the fair resolution of legal disputes, the quality of scientific evidence in the courts continues to be the subject of controversy.

In 1993, the U.S. Supreme Court in *Daubert v. Merrell Dow Pharmaceuticals* highlighted the obligation of judges to act as gatekeepers responsible for keeping unreliable scientific evidence from being admitted in litigation.[3] Following the *Daubert* decision, Judge Alex Kozinski, on remand, characterized the challenge for judges called upon to rule on the admissibility of expert scientific testimony:

> [T]hough we are largely untrained in science and certainly no match for any of the witnesses whose testimony we are reviewing, it is our responsibility to determine whether those experts' proposed testimony amount to "scientific knowledge," constitutes "good science," and was "derived by the scientific method."[4]

As Judge Kozinski's comments suggest and Justice Breyer's later observations indicate, *Daubert*, although it put more gatekeeping power in the hands of the judge, has far from resolved the tensions that arise when science appears relevant to litigation.[5]

Scientific societies have also focused on the stresses that exist between science and the law, often through the lens of ethics.[6] The American Psychological Association's code of conduct, for example, specifically addresses issues that arise when psychologists are called on to serve in forensic capacities.[7] The various, largely prosecution-oriented forensic sciences, spurred on by a critical National Academy of Sciences (NAS) report, have been working not only to increase the quality of their sciences but also to improve the accuracy and clarity of how forensic experts present their findings in court.[8]

A common explanation for complaints about the quality of the scientific evidence courts receive is the claim that "scientists tend to be leery of lawyers and the legal process, preferring not to venture into the courtroom."[9] Prior studies of experts in the American legal system provide some evidence of a disconnect between science and law, but the literature is sparse, consisting primarily of small surveys of testifying experts,[10] and four important case studies, each discussing cases from the pre-*Daubert* era: one involving an examination of court documents and interviews with the participants in six criminal and three civil cases that included scientific evidence,[11] and the other three analyzing court opinions in several cases involving statistical evidence.[12] Our current survey was designed to examine evidence for some of the themes touched on in this prior research (for example, dissatisfaction with the quality of opposing experts and questions about judicial competence) and to go beyond the prior research in examining in greater detail the response of experts to the legal system.

We designed our survey, in conjunction with the American Academy of Arts and Sciences' Public Face of Science project, to capture the views of distinguished scientists and engineers about the legal system and their experience with it. We surveyed scientists (including physical, biological, and social scientists) and engineers who were elected Fellows of the Academy.[13] We asked them whether lawyers or judges had ever requested their advice, whether they had ever agreed to help if asked, why they were willing to help and why they refused to provide help if they declined, and what their experience was if they assisted, and we sought their views on various aspects of the legal system and the system as a whole. We also explored their future willingness to participate in the legal system, and asked them whether certain proposed changes in legal procedures would affect that willingness to participate. Finally, we sought to determine whether participation correlated with and perhaps affected views of the legal system.

We were particularly interested in understanding how the legal system interacts (or doesn't) with the nation's most respected scientists and engineers. Not only are these people likely to have the most to offer the legal system, but if they are seen as willing to engage with the legal system, younger scientists and engineers may be more likely to follow. To capture the views of highly respected scientists

and engineers, we invited the members of the Academy in Class I (mathematical and physical sciences); Class II (biological sciences); and Class III (social sciences) to complete an online survey (n = 3328).[14] We obtained 366 responses, a response rate of 11.0 percent. The response rate is not as high as we had hoped, but our data constitute what is by far the largest number of scientists and engineers ever surveyed on their experience with, and perceptions of, the legal system.

Our response rate is similar to the 12.1 percent response rate that was obtained in a recent survey that sought to learn what members of another organization of scientists, the American Association for the Advancement of Science, thought about the FBI and law enforcement.[15] Hence we do not think the survey topic discouraged participation. To check for biases in our responding sample, we conducted a follow-up survey that could be answered in under five minutes, either by responding directly to questions on the email request or by going to a hyperlinked location like the one in the original survey. Two hundred fifty-three Academy members who had not responded to the original survey provided answers to this follow-up request. Those in our follow-up sample were similar to our sample respondents in gender, age, Academy class, whether they had ever been asked for assistance by the legal system, and how favorably they viewed the legal system. These similarities suggest that the experience and views of those who completed the initial full survey were not idiosyncratic. (See the methodological appendix posted at http://www.amacad.org/daedalus/whenlawcalls.) Moreover, this follow-up group gave us a larger total sample (n = 619) and a total response rate of 18.6 percent on which to examine participation rates and respondents' overall evaluations of the ability of the legal system to deal with science.

We also looked at how representative our respondents were by comparing the gender, age, and Academy class distributions of all Academy members and the initial sample. The distributions in the population and sample were substantially similar in these three categories. Sample respondents included a somewhat higher proportion of women (24 percent versus 17 percent).[16] And although the mean age in both the sample and population was seventy-one, the sample included a higher proportion of persons sixty-five or older (77 percent versus 69 percent) than is found in the overall population of Academy members.[17] The overrepresentation of those over sixty-five in the sample may reflect the less busy lives of partially or fully retired scientists, as well as the possibility that those who have in the past participated or been asked to participate as experts were more likely to respond than those without such experience, with older scientists likely having accumulated more opportunities to participate. Also, Class III members (social scientists and attorneys) responded at a somewhat higher rate than their proportion in the population (33 percent of respondents versus 28 percent of the population).[18] To see if these modest differences between the sample and population might distort our results, we conducted all analyses using both the unweighted responses and the responses weighted for gender, age, and class membership. Weighting did not change our results, so we use the unweighted data in presenting our findings.

While we cannot be certain that our sample respondents look like those Academy members who did not respond, there is little reason to suspect that the responses we received have serious relevant biases. Moreover, even if unknown biases exist, our survey sheds light on how a good proportion of the country's most distinguished scientists regard and interact with the legal system.

A majority (54 percent) of our respondents reported that they had been asked to provide expert scientific or engineering advice at least once. More than one-third (38 percent) said they had been asked three or more times, and one in six (17 percent) reported receiving ten or more requests.[19] If our nonrespondents were, as we expect, disproportionally people who were never asked for assistance, these rates are inflated; but note that a majority (60 percent) of respondents to our brief follow-up survey also said they had been asked for assistance. The request numbers suggest that the legal system approaches distinguished scientists and engineers for assistance with some frequency. Across disciplines, the most frequently asked experts worked in economics (87 percent), chemistry (81 percent), and engineering, computer sciences, and information technologies (80 percent). Next were noneconomist social scientists (72 percent). Those who reported the fewest requests were in the Academy's astronomy, physics, and earth sciences cluster (18 percent). Table 1 shows the full breakdown by disciplinary cluster.[20] These patterns make sense: experts in disciplines like astronomy are less likely to have expertise relevant to legal matters than experts in economics and chemistry.

When top experts are approached for assistance, they are likely to agree to provide it, at least on some occasions. In our sample, over 90 percent of those asked for advice agreed to assist at least once.[21] That willingness to serve is reflected in respondents' general agreement with the statement: "Absent strong reasons to the contrary, scientists should share their knowledge with the legal system when they are asked to serve as experts" (84 percent agreed or strongly agreed).[22]

About 10 percent of those who responded to our main survey never agreed to assist lawyers or judges when asked, while those who agreed to assist on one or more occasions may still turn down other requests. Why do they refuse? We asked respondents to check up to three of thirteen possible reasons for turning down requests, or to identify other reasons for refusing (Table 2). The most common reason for refusing to participate was "timing/other commitments" (66 percent). The demands faced by experts in legal matters can not only be time-consuming, but timing can also be unpredictable. Unlike experts who are full-time consultants or who are employed by the government to provide forensic expertise, professional scientists and engineers in both the academy and industry typically have jobs that make them only sporadically available to assist on legal issues. Strikingly few respondents mentioned formal organizational barriers to participation or advice against participating (6 percent), so it appears that few distinguished scientists are required by their employers' policies to turn down requests for assistance. Thus, it is time constraints rather than organizational restrictions that create a catch-22 for the legal system: the highest quality scientists have so much on their plates that they may be the least available to assist, even if they would otherwise be willing to do so.

The second most common reason for refusing to participate was that the "request was outside my area of expertise" (49 percent), an appropriate and desirable response since fit matters. The frequency of this response suggests that a system that helps lawyers and judges identify leading experts with knowledge specifically relevant to the issues in a case would increase the efficiency of searches for advice and might promote better expert advice in the legal system. In this connection, we asked those respondents who had provided assistance how, to the best of their knowledge, they had been identified by an attorney or judge as a potential expert.[23] Although commercial organizations provide directories of potential experts in various scientific and

Table 1
Academy Scientists Asked for Scientific or Engineering Advice, Requests by Discipline
Q: What is your field of scientific or engineering expertise?
Q: Has a party, attorney, or judge ever asked for your expert scientific or engineering advice?

	Ever asked for advice		
Fields of expertise	**Yes % (N)**	**No % (N)**	**Total % (N)**
Biological and cognitive sciences	50.5% (46)	49.5% (45)	100% (91)
Medical sciences	61.1% (11)	38.9% (7)	100% (18)
Astronomy, physics, and earth sciences	17.8% (8)	82.2% (37)	100% (45)
Chemistry	81.0% (17)	19.0% (4)	100% (21)
Mathematics and statistics	36.0% (9)	64.0% (16)	100% (25)
Social sciences except economics	71.8% (28)	28.2% (11)	100% (39)
Economics	86.7% (13)	13.3% (2)	100% (15)
Social and developmental psychology and education	57.1% (12)	42.9% (9)	100% (21)
Engineering, computer sciences, and information technologies	80.0% (20)	20.0% (5)	100% (25)
Law, including the practice of law	35.0% (7)	65.0% (13)	100% (20)
Total	53.4% (171)	46.6% (149)	100% (320)

engineering fields, attorneys, at least according to the respondents, rarely (6 percent) located them by using commercial referral sources. More commonly, respondents said they were identified through their scholarship, or their names were provided by another lawyer, another expert, or the client. It is likely, however, that scientists who are less publicly visible than Academy members and those for whom consulting is their primary professional activity would be more likely to be identified through commercial sources.

The next most common reason for refusal, offered by nearly one in four experts (24 percent) was that they "did not think the scientific or engineering evidence favored the party who wanted my knowledge." This response is inconsistent with willingness to be a "hired gun," a charge frequently leveled at expert witnesses. It may reflect the high quality of Academy experts and the fact that they do not need to rely on consulting for a dominant portion of their income. Expert refusals for this reason may have the positive consequence of leading attorneys to reassess the strength of their cases. They may, however, also encourage attorneys to search for more party-friendly

Table 2
Reasons for Turning Down Requests

Q: Thinking back to all the times you turned down requests to serve as an expert, what were your most common reasons for refusing? (Check up to three)

Reason	N Checked	% Checked
Timing/other commitments	89	65.9
Outside my area of expertise	66	48.9
Evidence didn't favor party asking	32	23.7
Doubts about the legal system (three items)	31	23.0
Particular parties or attorneys (two items)	28	20.7
Wanted my reputation, not my knowledge	28	20.7
Conflict of interest	15	11.1
Fee issues	10	7.4
Advice or institutional policy against (two items)	8	5.9
Other reasons	6	4.4
Total respondents (respondents could check up to three responses)	135	

experts, whether or not the party-friendly view has adequate scientific justification. Such searches, which can distort the quality or implications of the scientific evidence that finds its way into legal proceedings, are abetted by the absence of rules requiring attorneys to reveal the identities of all experts consulted in connection with a case. *Daubert* and its progeny should theoretically filter out the worst abuses of this sort, but the *Daubert* line of cases indicates it is a far from perfect filter.

Time constraints and mismatches are not the only reasons why the legal system loses potentially valuable scientific expert knowledge. Some experts indicated that they refused to assist because they had doubts about the legal system (23 percent). They questioned the ability of the adversary process to resolve science or engineering disputes, doubted whether the legal system could fairly resolve the dispute, or did not relish the prospect of being cross-examined. The majority (84 percent) of the respondents who expressed unease with the legal system had, however, agreed to assist in response to some requests and 68 percent had actually provided assistance. In some cases, their doubts were most likely stoked by their experiences.

Experts also turned down requests because they did not wish to assist particular parties or attorneys (21 percent). One respondent, for example, noted, "I will nev-

er work for a patent troll." To the extent that experts share preferences, some parties may find it difficult to obtain expert assistance.[24] An unequal supply of expertise may not undermine the quality of legal decision-making if expert preferences align with scientific merit, but it creates problems if they do not.

Respondents rarely identified fee issues as a reason why they refused requests for assistance (7 percent), although social desirability bias may have discouraged checking this response. It is, however, likely that fees are seldom the deal breaker for these scientists. As responses to this item indicate, other considerations seem to be more important. Not only are distinguished scientists and engineers likely to be able to command substantial compensation, at least in civil cases, but money may not be the principal motivator for the most successful, and typically the most highly paid, academic and industry scientists. Indeed, two respondents who cited fee issues said they refused to participate because "mostly attorneys did not want me to testify unless I would be paid, and I refused" and "[I] do not do this for the fees ever, but pro bono for the common good. Many requests I decline are for a fee which I do not feel appropriate to take." However, as we discuss below, promised financial compensation is a factor affecting the participation of some experts.

Taken as a whole, responses to our inquiry into why scientists choose not to participate in the legal system present a reassuring picture. Fewer than one in four of those refusing said they did so because of doubts about various aspects of the legal system, and only one respondent gave this as the sole reason for refusing to participate. Most often, the time needed to participate was a major factor (66 percent), and thirteen respondents (10 percent) gave time or organizational policies against participation as their only reasons for refusing. Perhaps most heartening is the degree to which ethical reasons appear to have motivated nonparticipation. These included admitted lack of expertise, feeling that the evidence did not favor the side that sought assistance, conflicts of interest, realizing that the lawyer making the request more highly valued the expert's reputation than knowledge, and not wanting to work for a particular client or attorney. Overall, 79 percent of our respondents listed at least one of these concerns as a reason for nonparticipation. There is almost no evidence in these data that the kinds of scientists elected to the Academy see themselves as, or are willing to be, "hired guns."

Participation as a testifying expert often involves a dramatic diversion from the central professional activities of Academy scientists and may be the most demanding role a scientific expert is called upon to play in the legal system. Our sample included ninety-four experts who indicated that in their most recent experience serving as an expert witness, they had testified in a hearing or trial. We asked them to evaluate the importance of various possible reasons for their willingness to participate as an expert in that case (see Table 3).

Consistent with a focus on scientific accuracy, the reasons our respondents rated as most important were the ability to assist in correctly resolving the case (85 percent) and the associated belief that the expert was testifying for the side that was scientifically correct (86 percent). Their side's moral correctness was an important reason for 72 percent of respondents, and more than half of respondents identified the obligation to share knowledge as an important motivation (64 percent). Nearly half (46 percent) said it was important that they thought it would be a learning experience. Only 30 percent said that wanting to affect law or policy was an important motivator.

A substantial minority (38 percent) said they viewed promised financial compensa-

Table 3
Importance of Reasons for Participating in Most Recent Case

Q: How important were each of the following reasons for your decisions to provide assistance in this case? (from 1 = Not very important to 5 = Extremely important)

Reasons for Participating (asked of those who indicated they had testified)	**Responded with Important or Very Important**
My expertise could assist in a correct resolution	85% (68/80)
Scientists have an obligation to share knowledge	64% (47/74)
My side was scientifically correct	86% (64/74)
My side was morally correct	72% (50/69)
A learning experience	46% (33/72)
Wanted to affect law or policy	30% (20/66)
Promised financial compensation	38% (25/66)

tion as an important factor motivating participation. Thus, although we found that experts seldom turned down requests to assist because they regarded the fees they would receive as insufficient, expert fees can be an incentive to participate. One expert explaining his participation commented, "I believe in sharing scientific knowledge and making legal decisions based on scientific knowledge, the cases are interesting, and I like the money." Another said, "I've been doing it for 40 years and overall greatly benefit from the experience. It enhances my research, teaching[,] collections of interesting life experiences, sense of helping the innocent and bank account." Several others said that in deciding whether to participate they considered both the time required and the level of compensation, with some noting they did not accept assignments when they felt their time would not be fairly compensated. Still others were quite blunt in describing the motivational effects of fees, including respondents who explained their willingness to participate in the future by writing, "compensation," "pay," and "[i]nterest, money." Still, when asked about the most recent case in which they testified, only 38 percent rated financial compensation as an important motivating reason, and most rated at least three other reasons as also important. Only one respondent gave money as the sole important motivation for providing assistance. Thus, although a few scientists refuse compensation for providing assistance, most expect to be compensated and many acknowledge that compensation is a motivator. Nonetheless, their motivations to assist do not appear to be driven solely or in most cases even largely by a profit motive.

Attorneys may ask the expert scientists and engineers they hire to testify at hearings or trials, to answer questions at depositions, or to write reports or affidavits. Reactions to these activities highlight differences between the legal system's demands and the way scientists and engineers generally spend their professional time.

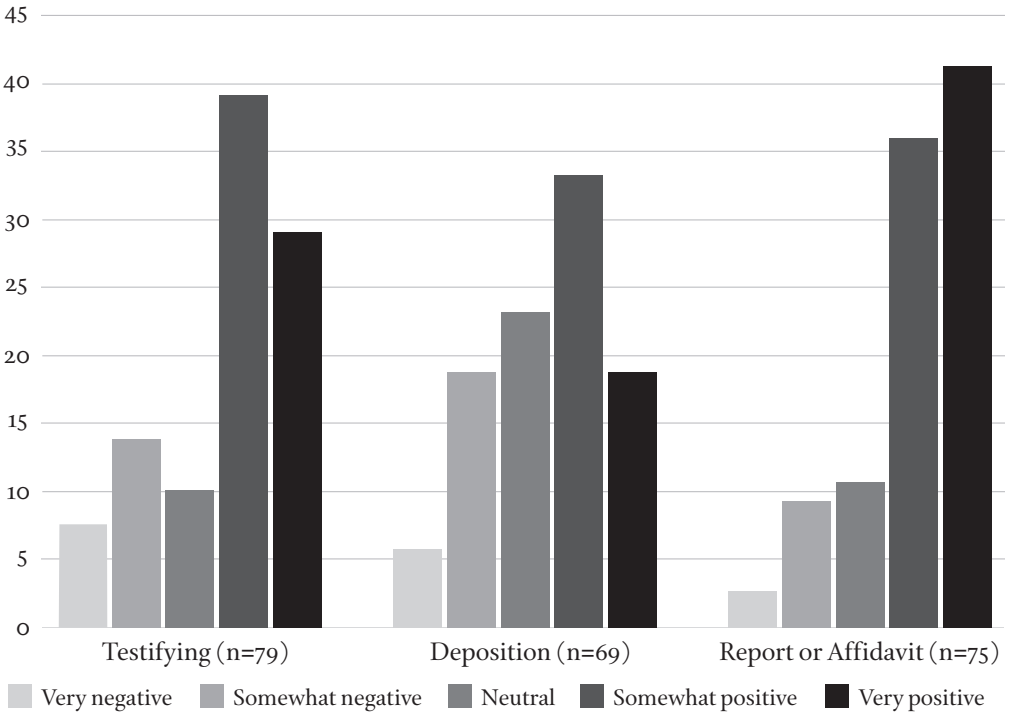
Court testimony typically follows a question-and-answer format. Unlike the classroom, where students may ask questions but the professor controls the flow (and number) of student remarks, in a courtroom the attorneys' questions seek to control how experts present their evidence and opinions. During direct examination, the questions come from the lawyer who hired the expert. This dialogue has typically been rehearsed, often incorporates the expert's suggestions, and is designed to persuade the judge and/or jury. In contrast, the opposing attorney's cross-examination typically attempts to constrain what the expert can say, sometimes in ways that will frustrate an expert whose strongest desire is to state the *whole* truth. The cross-examiner may also challenge not only the accuracy of the expert's opinions but sometimes the expert's competence and integrity as well. Not surprisingly, experts think more favorably of direct than cross-examination (81 percent versus 40 percent positive), and they see the lawyer on the side for whom they testified in a more positive light than the opposing side's lawyer (92 percent versus 31 percent positive).[25] Although some trial experiences generated complaints ("The entire process is reminiscent of a high school boy's locker room where attorneys try to play gottcha and to undermine rather than to reveal, reconcile, and allow the judge or jury to make informed decisions"), 68 percent of the experts who testified at trial rated the overall experience positively, including 29 percent who rated it very positively ("I enjoyed it – learned a lot – a different world").

In a deposition, unlike in a trial, only the opposing attorney asks questions, and no judge is present. Moreover, the rules of evidence, including rules of relevance, are relaxed. The expert in a deposition thus lacks the opportunity that a trial presents to educate a neutral decision maker, and is subject to cross-examination without a judicial referee to limit the nature or extent of the questioning. As with the trial experience, experts rated the deposition behavior of the attorney for their side more positively than the behavior of the opposing attorney (78 percent versus 25 percent). Some respondents, given the opportunity to elaborate, showed impatience with the experience ("only fishing expeditions"; "I don't like having my integrity questioned"). Experts who were deposed were on average less positive about the overall experience than those who testified: 52 percent rated it as positive, including 19 percent who rated it as extremely positive.

Unlike the trial testimony and deposition experience, report writing is familiar territory for scholars. Although an expert report or affidavit in litigation differs in form from that of a scholarly article, the expert in both instances is describing what she believes and the evidence supporting that belief. Experts by and large approved of (81 percent positive) the cooperation they received from the attorney who asked them to write a report. They reported that the attorney was willing to accept their independent view (91 percent) and that their report influenced the attorney's beliefs about the case (83 percent). Overall, writing a report or affidavit was the part of the litigation assistance process viewed most favorably (77 percent positive, including 41 percent very positive). Figure 1 shows how reactions to these three kinds of involvement differ.[26]

What we see reflects the generally positive view that expert participants have of their experience, but it also echoes a distaste for adversary procedures that some

Figure 1
Expert Evaluations of the Overall Experience: Testifying, Deposition, and Report or Affidavit Writing



experts identified as a reason why they refused to participate on one or more occasions.

We noted earlier that 90 percent of experts who had been asked for assistance had agreed to assist at least once. We also saw that experts often turn down invitations to serve. What about future service? We asked all respondents, "If you are asked in the future to serve as an expert in litigation, how likely is it that you would agree to serve?" One-third of our respondents (34 percent) said they were likely or very likely to serve, and 39 percent said they were uncertain. The remaining 28 percent said they were unlikely or very unlikely. We asked the ninety-five respondents who said they were unlikely to serve to tell us why they would be unlikely to serve. Of the eighty-five individuals who responded to this follow-up question,[27] sixteen mentioned being too old or that they had retired, and twenty-two mentioned being too busy, but thirty – one-third of these respondents – mentioned some distasteful reaction to courtroom behavior ("Accurate communication is extremely difficult and generally not desired by either side"; "Litigation sucks") or the adversary system ("Don't like being cross-examined"; "Because my experience was that my scientific expertise was not at issue – I was (unfairly) accused of inconsistent behavior"; "The experience of being deposed was horrible") or the inconsistent demands of science and law ("I am uncomfortable now in the adversarial system in courts dealing with

scientific matters"; "Often have difficulty with how scientific facts are distorted in legal proceedings to project what is wanted rather than what is true"). Twelve of the negative responses came from those who reported experience in providing expert assistance, while eighteen came from respondents who had no experience, thus reflecting a combination of responses to prior experience and images of the legal system not based on personal experience that mitigated against participation.[28]

Although many of these objections and sources of discomfort arise from intrinsic features of the American legal system and some are the legacy of a past unpleasant experience, other perceived problems may be open to adjustment. Thus, we assessed our respondents' reactions to potential changes in trial procedure that might make participation more attractive to experts. This effort focused on four procedural variations that might affect a respondent's willingness to participate in a legal proceeding.[29]

Being asked by a judge to serve as a court-appointed expert (see Daniel Rubinfeld and Joe Cecil's contribution to this volume) had the most appeal, leading more than two-thirds of the respondents (69 percent) to say that they would be more likely to serve if asked to be a court-appointed expert (Table 4).[30] This was particularly true among those who expressed uncertainty about future participation; 77 percent of those respondents said they would be more likely to participate if asked to serve the court rather than a party.[31] Moreover, few respondents, whatever their current inclination to serve, said they would be less likely to assist if the request came from a judge (2 percent overall).

A majority of respondents (59 percent) were also attracted by the idea of meeting privately with opposing experts and writing a joint report that indicated areas of agreement and disagreement. This option was particularly attractive to scientists currently uncertain about their future willingness to serve, leading 72 percent of them to say the change would make them more likely to participate.[32] Nonetheless, for some respondents, this change would decrease their willingness to serve (9 percent overall).

These two favored procedural modifications appear likely to diminish the adversarial nature of the expert experience. Court-appointed experts do not have partisan clients, and the opportunity to produce a joint report with the opposing expert potentially avoids or reduces clashes of expertise. The lesser enthusiasm for the third suggested change, permitting opposing experts to question one another in open court, is telling. Overall, less than one-third (32 percent) said it would increase their willingness to serve, and for one in five (22 percent), the change would make them less likely to serve. Even 14 percent of those who identified themselves as currently likely to participate said this procedural modification would make them less likely to serve. Thus, respondents expressed little interest in engaging in attorney-like adversary procedures by questioning and being questioned by an opposing expert. This is not because they reject all questioning. A majority of respondents (58 percent) liked the idea of allowing jurors to pose questions to them and few (3 percent) rejected it, perhaps because the procedure emulates a professor's availability to answer student questions. Overall, our results suggest that the supply of high-quality expertise can be expanded if the legal system creates procedural options that emulate scientific and academic exchange. Such procedural adjustments would reduce attorney control and may seem inconsistent with the traditional adversary system of the United States, but other common law countries with adversary systems, like Canada and Australia, have taken steps in this direction.[33]

Table 4
How Potential Procedural Modifications would Affect Future Willingness to Participate in Light of Current Willingness to Participate

	Current Willingness to Participate in the Future			
Change in Future Willingness to Participate in Response to Potential Procedural Modifications	**Unlikely to Participate in Future**	**Uncertain about Future Participation**	**Likely to Participate in Future**	**Total**
	27.8% (n=95)	**38.6% (n=132)**	**33.6% (n=115)**	**100.0% (n=342)**
If I were asked by a judge or arbitrator to serve as a court-appointed expert rather than by a party as an adversary expert:				
Would be more likely	63.6%	77.2%	63.2%	68.7%
No effect	34.1%	22.8%	32.5%	29.2%
Would be less likely	2.3%	0.0%	4.4%	2.1%
	100.0%	100.0%	100.1%	100.0% (n=329)
If I were permitted to meet privately with opposing experts to discuss issues and write a joint report indicating areas of agreement and areas of disagreement:				
Would be more likely	45.5%	72.2%	55.0%	59.1%
No effect	46.6%	19.8%	33.3%	31.7%
Would be less likely	8.0%	7.9%	11.7%	9.2%
	100.1%	99.9%	100.0%	100.0% (n=325)
If I could question opposing experts in court and they could question me:				
Would be more likely	25.3%	33.1%	37.2%	32.4%
No effect	50.6%	40.3%	48.7%	46.0%
Would be less likely	24.2%	26.6%	14.2%	21.6%
	100.1%	100.0%	100.1%	100.0% (n=324)
If I could answer juror questions after I gave my testimony:				
Would be more likely	44.3%	63.2%	62.2%	57.7%
No effect	50.0%	34.4%	36.9%	39.5%
Would be less likely	5.7%	2.4%	0.9%	2.8%
	100.0%	100.0%	100.0%	100.0% (n=324)

We have seen that the scientists in this survey often expressed frustration with legal procedures and, in some cases, a suspicion that those procedures were purposefully designed to avoid getting at the truth. How did the scientist-respondents as a whole view the success of the legal system in producing decisions that accord with sound science? Overall, we found that 60 percent of our respondents saw the legal system as very or somewhat successful while 40 percent had the opposite view.[34] What explains this division of opinion? One possibility is that experience with the legal system leads to greater familiarity and more positive attitudes. Another is that experience and familiarity engender disappointment and cynicism, evoking more negative attitudes. As a first step, we compared the attitudes of those with and without experience providing advice. Those with experience rated the legal system as significantly more successful, with 70.0 percent of participants seeing the system as somewhat or very successful, while only 53.5 percent of the nonparticipants expressed that favorable view.[35] This difference was also reflected in other perceptions and attitudes toward the legal system. Participants rated lawyer understanding of science more favorably than nonparticipants, saw scientists as treated with more respect, and viewed serving as an expert witness more favorably as a way to keep abreast of the real world implications of their science. Participants did, however, express somewhat greater criticism for experts, indicating greater agreement than nonparticipants with the belief that even respected experts may compromise their standards in the context of the legal system (Table 5).

Although this overall pattern undercuts the hypothesis that experience tends to undermine confidence in the legal system, we cannot be certain that it promotes it. People may agree to participate because they view the legal system positively (selection effect), their view may be shaped by their participation (experience effect), or both may help explain the correlation.

A modest quasi control group bears on the relative plausibility of the selection and experience effects (Table 6). Thirty-two respondents agreed at least once to participate but never actually participated. We did not ask why their agreement did not result in participation, but given how the litigation process works, we expect the most common reason is that the case was withdrawn or there was a quick settlement or plea agreement. The pattern of responses from this agreed-but-never-participated group was closer to the never-asked group than to the group of participating respondents (Table 6).

The groups differed significantly on four statements in Table 6 (different subscripts indicate significant differences on the post hoc comparisons). In each of these comparisons, the "never asked" and "participated" groups differed from one another. On the evaluation of lawyer understanding, the participated group was distinctive: only participation was associated with an increased evaluation of the ability of lawyers to understand science. This pattern is consistent with an increased appreciation of how well lawyers understand science arising from close interaction. It may also be a biased view of how well lawyers understand science since those lawyers who hired scientific experts and worked with them may be better able to grasp scientific concepts than the general run of attorneys.

Most important, we compared the groups on their views about the success of the legal system in dealing with scientific matters. Again, the participants viewed the legal system as more successful (70.0 percent) than both those never asked (52.5 percent) and those who agreed but did not have an opportunity to participate (51.6 percent). The pattern is only suggestive in light of the small number of quasi control respondents

Table 5
Perceptions of and Attitudes toward the Legal System by Participants and Nonparticipants*

	Never Participated (n=201)	Participated (n=124)	p-level**
Science should aid law[a]	4.09	4.00	ns
Judges can understand science[b]	2.81	2.85	ns
Jurors can understand science	2.44	2.39	ns
Lawyers can understand science	2.80	3.18	$p < .001$
Scientists are treated with respect[c]	3.14	3.43	$p < .002$
Experts compromise standards[d]	3.17	3.37	$p < .05$
Links real world and science[e]	2.75	3.12	$p < .003$
Success of legal system with science (% successful)[f]	53.5%	70.0%	$p < .002$

* Scale ranges from 1 (strongly disagree) to 5 (strongly agree)

** "p <" = significant level; ns = not significant at the .05 level

[a] "Absent strong reasons to the contrary, scientists should share their knowledge with the legal system when they are asked to serve as experts."

[b] "In cases where science is important to the decision, most judges and arbitrators have the ability to understand scientific evidence and the scientific process." The next two items substitute "most juries contain jurors who" and "most lawyers" for "most judges and arbitrators."

[c] "Scientists are treated with appropriate respect when they testify at trials or in depositions."

[d] "Even respected scientific and engineering experts may compromise their scientific standards and write reports or give testimony [that] better support the position of the party that hired them."

[e] "Serving as an expert witness is a good way for scientists to keep abreast of the real world implications of their sciences."

[f] "In litigation or arbitration where scientific or engineering issues are involved, on average, how successful do you think the American legal system is in producing results that reflect sound scientific or engineering knowledge?" (percent somewhat or very successful).

Table 6
Perceptions of and Attitudes toward the Legal System with Quasi Control Group*

	Never asked (n=152)	Participated (n=124)	Asked and agreed but did not participate (n=32)	Overall p-level**
Science should aid law	4.14	4.00	3.97	ns
Judges can understand science	2.80	2.85	2.94	ns
Jurors can understand science	2.42	2.39	2.41	ns
Lawyers can understand science	2.82_a	3.18_b	2.75_a	$p < .005$
Scientists are treated with respect	3.15_a	3.43_b	3.24_{ab}	$p < .01$
Experts compromise standards	3.18	3.37	3.10	ns
Links real world and science	2.72_a	3.12_b	2.90_{ab}	$p < .007$
Success of legal system with science	$52.5\%_a$	$70.0\%_b$	$51.6\%_a$	$p < .01$

* Scale ranges from 1 (strongly disagree) to 5 (strongly agree)

** "p <" = significant level; ns = not significant at the .05 level

Note: Subscripts indicate significant differences on the post hoc comparisons.

and the unknown reasons why they did not end up participating. Nevertheless, we provided an opportunity to support the possibility that our results were the result of preexisting views of the legal system, and the data fell in the opposite direction.

This survey provides unique information about how scientists interact with and view the legal system. There are aspects of our data that we have yet to plumb, but even after further analysis, we must be careful in generalizing from our results: The findings we report may characterize only, or largely, the kinds of scientists who achieve substantial success in their fields. We do not know how scientists who market themselves as scientific experts, including scientists who work for consulting firms or the large group of forensic scientists who testify regularly for the prosecution, would answer the questions we posed.[36] Also, given the age and accomplishments of Academy members who are scientists, we cannot be certain how the generation of scientists now entering the most productive portions of their careers view the legal system or would respond to proposed changes in legal procedure. Nevertheless, the snapshot we provide of the group of eminent scientists who responded

to our survey is an important one. Our respondents have expertise that is crucial for a legal system that must increasingly take account of scientific understandings and will be well served only if the science available to it is both clear and sound.

In this respect, the good news is that the Academy survey reveals that the legal system has often been able to draw on distinguished scientists and engineers for assistance when scientific and engineering questions intersect with the law. This capacity can be expected to continue into the future. When asked, most scientific experts are willing to participate in legal actions, at least some of the time. Still, the relationship has its trouble spots, including some discomfort with the adversary system, that seem to reflect the different cultural norms of science and law. Although our survey responses suggest that several modest changes in trial procedures could have positive effects for both experts and triers of fact, as other essays in this volume indicate, tensions between science and the law are unlikely to ever completely disappear.

AUTHOR BIOGRAPHIES

SHARI SEIDMAN DIAMOND, a Fellow of the American Academy since 2012, is the Howard J. Trienens Professor of Law and Professor of Psychology at the Northwestern University Pritzker School of Law, and Research Professor at the American Bar Foundation. She is the author of the *Reference Guide on Survey Research* in the *Reference Manual on Scientific Evidence* (3rd ed., 2011) and *The Multiple Dimensions of Trial by Jury: Studies of Jury Behavior* (2016, in Spanish) and editor of *Trademark and Deceptive Advertising Surveys: Law, Science, and Design* (with Jerre B. Swann, 2012).

RICHARD O. LEMPERT, a Fellow of the American Academy since 1993, is the Eric Stein Distinguished University Professor of Law and Sociology, emeritus, at the University of Michigan. He is the author of *A Modern Approach to Evidence: Text, Problems, Transcripts, and Cases* (with Samuel Gross et al., 5th ed., 2013) and *An Invitation to Law and Social Science* (with Joe Sanders, 1986) and editor of *Evidence Stories* (2006).

AUTHORS' NOTE

Our thanks to Beth Murphy, American Bar Foundation, and Eleanor Wilking, Northwestern University Pritzker School of Law, for their excellent assistance. We are grateful to the American Academy of Arts and Sciences and to the American Bar Foundation for funding support. We are also grateful for valuable feedback from the authors of the other essays in this volume who were participants in the American Academy of Arts and Sciences meeting.

ENDNOTES

1 *The tryal of Spencer Cowper, Esq, John Marson, Ellis Stevens, and William Rogers, gent. upon an indictment for the murther of Mrs. Sarah Stout, a Quaker before Mr. Baron Hatsell, at Hertford assizes, July 18, 1699*, 45, http://quod.lib.umich.edu/e/eebo/A63196.0001.001/1:3?rgn=div1;view=fulltext. The judge went further: "Dr. Brown has a learned discourse in his Vulgar Errors upon this subject, concerning the floating of dead bodies, I don't understand it my self, but he hath a whole chapter about it." Ibid., 16.

2 Stephen Breyer, "The Interdependence of Science and Law," *Science* 280 (5363) (1998): 537.

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

4 *Daubert v. Merrell Dow Pharmaceuticals, Inc.*, 43 F.3d 1311, 1316 (9th Cir. 1995), *cert. denied*, 116 S.Ct. 189 (1995).

[5] Sophia I. Gatowski, Shirley A. Dobbin, James T. Richardson, et al., "Asking the Gatekeepers: A National Survey of Judges on Judging Expert Evidence in a Post-*Daubert* World," *Law & Human Behavior* 25 (5) (2001): 433; and John Meixner and Shari Seidman Diamond, "The Hidden *Daubert* Factor: How Judges Use Error Rates in Assessing Scientific Evidence," *Wisconsin Law Review* 2014 (6) (2014): 1063.

[6] Andre A. Moenssens, "Ethics: *Codes of Conduct for Expert Witnesses*," in *Wiley Encyclopedia of Forensic Science*, ed. Allan Jamieson and Andre A. Moenessens (Hoboken, N.J.: Wiley-Blackwell, 2016).

[7] American Psychological Association, "Ethical Principles of Psychologists and Code of Conduct" [amended February 20, 2010], *American Psychologist* 57 (2002): 1060 – 1073.

[8] National Research Council, *Strengthening Forensic Science in the United States: A Path Forward* (Washington, D.C.: National Academies Press, 2009). The federal government responded to the NAS report on the state of the forensic sciences first with the formation of an interagency task force to consider the report's critiques and recommendations, and then with the establishment of the National Commission on Forensic Sciences, a distinguished panel of academics, judges, prosecutors, forensic scientists, and defense counsel, charged with assessing and ensuring the scientific integrity of the various forensic sciences. The Commission was, however, terminated after President Trump took office. Still ongoing, as we write, is a National Institute of Standards and Technology–Department of Justice effort in which representatives of the various forensic sciences are working to establish performance and communication standards for their disciplines.

[9] National Research Council, *A Convergence of Science and Law* (Washington, D.C.: National Academies Press, 2001). The concern of courts and the legal academy is not that lawyers cannot find experts. Rather, the concern is with the pool of available experts, their biases and scientific competence, and their effectiveness in communicating their scientific opinions fairly and clearly in court. Hence the Council's concern is with factors that discourage the most able scientists from lending their expertise to the courts.

[10] A two-part survey: Anthony Champagne, Daniel Shuman, and Elizabeth Whitaker, "An Empirical Examination of the Use of Expert Witnesses in American Courts," *Jurimetrics Journal* 31 (4) (1991): 375; and Daniel W. Shuman, Elizabeth Whitaker, and Anthony Champagne, "An Empirical Examination of the Use of Expert Witnesses in the Courts – Part II: A Three City Study," *Jurimetrics Journal* 34 (2) (1994): 193. See also Jonathan Baker and M. Howard Morse, *Final Report of Economic Evidence Task Force*, Task Force on Economic Evidence (Chicago: American Bar Association, 2006), Appendix II.

[11] Michael J. Saks and Richard Van Duizend, *The Use of Scientific Evidence in Litigation* (Williamsburg, Va.: National Center for State Courts, 1983).

[12] Stephen E. Fienberg, ed., *The Evolving Role of Statistical Assessments as Evidence in the Courts* (New York: Springer, 1989). Joseph B. Kadane and Caroline Mitchell, "Statistics in Proof of Discrimination Cases" and Richard O. Lempert, "Befuddled Judges: Statistical Evidence in Title VII Cases" in *Legacies of the 1964 Civil Rights Act*, ed. Bernard Grofman (Charlottesville: University of Virginia Press, 2000), 241 – 262 and 263 – 281, respectively, both analyze court responses to expert evidence in the same seventeen cases.

[13] We developed the survey with assistance from John Randell and Keerthi Shetty at the American Academy. We revised our draft and improved it substantially following conference calls with scientists, engineers, and legal scholars who had reviewed the original draft of the survey, as well as with the benefit of a conversation with Justice Stephen Breyer (December 2015 – January 2016). Robert Townsend of the American Academy formatted and distributed the online survey in two waves (April 2016 and September 2016).

[14] This group also included sixty Academy members from Class V (public affairs, business, and administration) whose substantive expertise was in science or engineering.

[15] Nathaniel Hafer, Cheryl J. Vos, Karen McAllister, et al., "How Scientists View Law Enforcement," *Science Progress*, February 2009. (The American Association for the Advancement of Science and the American Academy of Arts and Sciences share the AAAS acronym, but are

different organizations with different memberships. The Association in the Hafer et al. survey is a voluntary subscription organization, while the Academy Fellows we surveyed were scientists nominated by their peers and voted into the Academy based on their professional accomplishments.) See also Brian J. Love, "Do University Patents Pay Off? Evidence from a Survey of University Inventors in Computer Science and Electrical Engineering," *Yale Journal of Law and Technology* 16 (2) (2014): 285, 299 [reporting an 11.3 percent response rate].

[16] Chi-squared = 9.16, $p < .003$. The higher response rate for women is not unusual: see, for example, William G. Smith, *Does Gender Influence Online Survey Participation? A Record-Linkage Analysis of University Faculty Online Survey Response Behavior* (San José, Calif.: San José State University, 2008), http://files.eric.ed.gov/fulltext/ED501717.pdf; it also occurred in the follow-up sample (23 percent women).

[17] Chi-squared = 8.14, $p < .005$. Although the mean age in the follow-up survey was seventy-one, the distribution of respondents was somewhat closer to the population, with 74 percent aged sixty-five or older.

[18] In contrast, Class III members were somewhat underrepresented in the follow-up survey (26 percent), so that together the two surveys had representation from Class III that was similar to the population (30 percent versus 28 percent). The other two classes had nearly identical representation in the population, first, and second surveys (Class I: 37.5 percent, 35.5 percent, 39.1 percent; Class II: 34.1 percent, 31.1 percent, 34.8 percent).

[19] Sixty percent in the follow-up survey reported they had been asked at least once, 33 percent at least three times, and 12 percent ten or more times.

[20] These percentages are based on disciplinary categories with at least ten respondents. We did not obtain disciplinary information in the follow-up survey.

[21] In the follow-up survey, 84 percent of respondents agreed to assist at least once. Accepted invitations did not always result in participation: 20 percent of those in the original sample and 4 percent in the follow-up survey who agreed did not end up participating.

[22] Respondents could also answer that they were undecided, disagreed, or strongly disagreed. Agreement with some other statements was considerably less; for instance, agreement rates with assertions that most judges and arbitrators (30 percent), jurors (12 percent), and lawyers (39 percent) have the ability to understand scientific evidence and the scientific process.

[23] Respondents were asked to choose all applicable sources from the following list: my scholarship (77 percent); an expert referral organization (6 percent); a referral from another lawyer (21 percent); name provided by the client (23 percent); recommended by another expert (22 percent); don't know (7 percent).

[24] Joseph Sanders, Betty Rankin-Widgeon, Debra Kalmuss, and Mark Chesler, "The Relevance of 'Irrelevant' Testimony: Why Lawyers Use Social Science Experts in School Desegregation Cases," *Law and Society Review* 16 (3) (1981–1982): 403 [plaintiff lawyers appear to have easier access to a network of scholars willing to testify].

[25] Respondents rated various features of the trial, deposition, or report/affidavit on a 5-point scale: very negative, somewhat negative, neutral, somewhat positive, very positive.

[26] A subset of thirty-five respondents provided all three ratings because their most recent experience had required a report, a deposition, and testimony. The pattern for this subset mirrored the results in Figure 1.

[27] Two of those who said they were unlikely to serve were federal judges and eight who said they were unlikely to serve did not indicate why.

[28] The third and seventh quotes in the text came from respondents without experience; the remaining came from respondents with prior experience.

[29] For each potential change, respondents were asked: If [change was made], I would definitely be more likely to participate; I would probably be more likely to participate; It would have

no effect on my decision whether to participate; I would probably be less likely to participate; I would definitely be less likely to participate.

[30] Daniel L. Rubinfeld and Joe S. Cecil, "Scientists as Experts Serving the Court," *Dædalus* 147 (4) (Fall 2018).

[31] Chi-squared$_4$ = 10.51, p < .04.

[32] Chi-squared$_4$ = 19.74, p < .001.

[33] See Ian Freckelton QC, Jane Goodman-Delahunty, Jacqueline Horan, and Blake McKimmie, *Expert Evidence and Criminal Jury Trials* (Oxford: Oxford University Press, 2016), chap. 3.

[34] Respondents were asked to rate the legal system's success by choosing among four options: very successful, somewhat successful, somewhat unsuccessful, very unsuccessful.

[35] Chi-squared = 8.31, p < .004. This pattern was replicated in the follow-up survey. Sixty-eight percent of participants viewed the legal system as successful, while 61 percent of the nonparticipants did; Chi-squared for the combined samples = 9.15, p < .002. Neither age nor gender was associated with this view. A majority of all three Academy classes viewed the system as successful, although Class II members (biological sciences) were least positive (55.8 percent), Class I members (mathematical and physical sciences) were more positive, and Class III (social sciences) were most positive (67.9 percent) (Chi-squared$_2$ = 5.36, p < .07). Nonetheless, within each class, those who had participated as experts in the legal system were more likely to view the legal system as successful than those who had not. When age, gender, Academy class, and participation are used to predict judged success, only participation is a significant predictor (Wald = 7.09, p < .01).

[36] Among those respondents who said they had provided assistance, most (84 percent) said they had assisted primarily in civil cases, 11 percent primarily in criminal cases, and 5 percent in both about equally. Assistance in civil cases was fairly evenly divided, with 33 percent primarily assisting plaintiffs, 27 percent primarily assisting defendants, and 40 percent assisting both about equally. Among the small group of 14 respondents who reported experience assisting in criminal cases, half (7) primarily assisted the defense, 4 primarily the prosecution, and 3 both sides about equally. The Academy sample thus included little if any representation from the large cadre of government-employed forensic scientists who regularly appear in criminal court cases.

Law & Neuroscience: The Case of Solitary Confinement

Jules Lobel & Huda Akil

Abstract: This essay discusses the interface between neuroscience and the law. It underscores the potential for neuroscience to break down the division that currently exists in law between physiological and psychological harm and between physical and mental injury. To show how scientific knowledge can illuminate a complex legal issue, we analyze the recent use of neuroscience in evaluating the harm caused by prolonged solitary confinement.

JULES LOBEL holds the Bessie McKee Walthour Endowed Chair at the University of Pittsburgh School of Law. He is the author of *Less Safe, Less Free: The Failure of Preemption in the War on Terror* (with David Cole, 2007), *Success Without Victory: Lost Legal Battles and the Long Road to Justice in America* (2003), and *A Less than Perfect Union: Alternative Perspectives on the U.S. Constitution* (1988).

HUDA AKIL, a Fellow of the American Academy since 2004, is the Quarton Professor of Neurosciences and Codirector of the Molecular & Behavioral Neuroscience Institute at the University of Michigan. She has published articles in such journals as *Nature*, *Nature Medicine*, *Science*, and *Journal of Neuroscience*.

Neuroscience is increasingly used in the courtroom, in a variety of circumstances.[1] Over the past decade or so, the distinct field of "law and neuroscience" has developed (sometimes termed "neurolaw"), a casebook on law and neuroscience has been published, courses on the subject are being taught in law schools and other departments, and the John D. and Catherine T. MacArthur Foundation has invested over $15 million in developing the Law and Neuroscience Project and Research Network.[2] Neuroscience testimony in the courtroom has, to date, largely focused on issues relating to criminal responsibility, with defense attorneys seeking to introduce brain scans of defendants to show that either they were not responsible for their actions or to argue that brain defects or problems justified mitigated penalties.[3]

Possible uses of neuroscience in the law go far beyond criminal cases, however. Neuroscience has the potential to bridge the divide in American law and culture between physical and mental injuries. For instance, it could enable judges to allow plaintiffs to recover damages in tort actions where mental harm may be uncompensable or disbelieved, but provable brain damage can be viewed as a physical injury.[4] Brain damage can be structural, such as a tumor or dimin-

© 2018 by the American Academy of Arts & Sciences
doi:10.1162/DAED_a_00520

ished volume of a particular brain region, and/or it can be functional, such as a characteristic change in the activity of a brain circuit implicated in certain conditions, including severe chronic stress or depression, chronic pain, or loss of cognitive function. So, too, neuroscience might be useful in helping judges to understand the mental harms that government action can inflict and to determine whether the infliction of mental harm, intended or not, rises to the level of a constitutional violation.

This is already happening in one area: expert neuroscience evidence is being mustered to support claims of extreme and long-lasting, if not permanent, mental harm in constitutional challenges to prolonged solitary confinement, a disciplinary practice used in many state and federal prisons. Thus, in the class action case of *Ashker v. Governor*, challenging the solitary confinement of more than one thousand prisoners at Pelican Bay State Prison in California, the plaintiffs submitted expert neuroscience testimony in support of their Eighth Amendment claims that such prolonged confinement constitutes cruel and unusual punishment.[5] This essay reviews the current intersection between the law and neuroscience and then explores and analyzes neuroscience's use in evaluating the harm caused by prolonged solitary confinement.

At first, the connection between the law and neuroscience may seem surprising; the "Law and neuroscience seem strange bedfellows."[6] As legal scholar David Faigman has noted, there is a "fundamental divide between the fields of neuroscience and law," an observation that could also be made about the law and other fields in mainstream science.[7] Neuroscientists study the brain and are generally unconcerned with legal questions, while lawyers, as smart as they may be, usually know nothing about how the brain works and are not troubled by their ignorance. Yet the law and lawyers are ultimately concerned with regulating human behavior, and issues of intent are part of the grist in the legal mill. Understanding the brain is central to both the law and neuroscience; thus, the burgeoning interplay between the two fields should not be surprising.

Perhaps the most salient source of tension between the two fields has to do with the differing goals of the scientist and the lawyer. The scientist studying the brain is ideally a neutral analyst, an empiricist who pursues evidence to generate a better understanding of brain function regardless of preconceptions. The lawyer is ordinarily not neutral, but rather is an advocate for his or her client's interests. A scientist is only supposed to draw a definitive conclusion when findings are replicable to a very high degree. Yet lawyers and judges are seldom in a position to withhold judgment. They can, and often must, evaluate evidence bearing on a claim, even if it is not conclusive. Moreover, in civil cases, the usual standard of proof is not the scientific standard, which demands substantial certainty, but rather the preponderance of evidence, which translates into "more likely than not."

This difference leads to tensions that bear on both the potential uses and the need for caution when using neuroscience evidence in legal contexts. Lawyers would like to present favorable neuroscience evidence as dispositive, yet scientific norms specify that neuroscience claims should not be oversold. This does not mean that the neuroscientist cannot or should not advocate positions based on the science as we know it now, even if current science provides only strongly probable but not scientifically conclusive confirmation of a relationship. It does, however, mean that the neuroscience expert must admit, and indeed should proactively bring forth, the existence of scientifically sound conflicting evidence or underscore areas where current knowledge is

either lacking or too weak to support strong conclusions. In these circumstances, neuroscience advocacy is most likely to be relied upon by courts when its conclusions are consistent with common sense.[8]

Neuroscientific evidence has been used with significant success to mitigate punishment, particularly in capital cases.[9] In the juvenile death penalty case *Roper v. Simmons*, the Supreme Court seems to have utilized such evidence in support of its decision that it is unconstitutional to impose capital punishment on a minor.[10] Yet some of the more radical claims made by neuroscientists, like the claim that brain imaging undermines the whole basis of criminal responsibility, have been deeply controversial and have not gained much traction in the courts.[11] Moreover, outside of the criminal mitigation context, most efforts to introduce neuroscience evidence in courts have proven unsuccessful.[12] Nonetheless, neuroscience evidence continues to be introduced in civil cases.

There appear to be two broad ways in which neuroscience evidence has made its way into the legal system. The first is the use of case-specific evidence from brain imaging, such as Magnetic Resonance Imaging (MRI) and Positron Emission Tomography (PET) scans, to demonstrate a particular criminal defendant's defective ability to make rational decisions or to show harm to the brain suffered by a plaintiff.[13] The second use, more important to this essay, is as what has been termed *framework* or *foundational scientific evidence*: scientific testimony bearing on how other evidence should be used based on general theories or hypotheses.[14]

These and other uses of neuroscientific evidence have the potential to break down the sharp dividing line the law has erected between mental injury and bodily harm. In diverse fields of law, from torts to constitutional law, the legal system treats mental harm differently from physical harm. Tort law traditionally makes a distinction between physical and emotional harm, "with emotional harm being treated as a second class citizen."[15] For example, to recover for the negligent infliction of emotional distress, a majority of states require the plaintiff to show not merely mental or emotional harm, but also physical injury.[16] The reasoning that the courts generally provide for this limitation is that mental harm, unlike physical injury, is essentially subjective and therefore the physical injury requirement will give "a sufficient basis for the trial courts to determine [that the claims of mental harm are] not . . . fraudulent claims."[17] Although often reaffirmed, this nexus requirement emerged many years ago, long before the capabilities that modern neuroscience gives us existed.

The American Law Institute's recent Third Restatement of Torts incorporates as a general rule this clear distinction between physical or bodily injury and mental or emotional injury.[18] It does, however, allow for claims of intentional or negligent infliction of pure, stand-alone emotional harm, but only in very circumscribed circumstances, citing, among other things, concerns that "emotional harm is less objectively verifiable than physical harm" and that "some degree of emotional harm is endemic to living in society."[19]

Neuroscience research at least muddies the distinction between bodily injury and mental harm, and, in the future, it might negate it entirely. One tool that neuroscience can deploy is brain imaging, which allows a window into the altered functioning of the brain under different conditions. This approach has been used to study chronic pain, considered the greatest source of disability worldwide. Neuroimaging has shown that chronic pain does indeed change brain function, altering specific neural pathways broadly, leading some to classify it as a neurodegenerative disorder. The brain changes resulting from chronic pain may not yet

reach the standard of being diagnostic on their own. Nevertheless, they are reliable enough to motivate recent reviews putting forward neuroimaging strategies as a potential basis of evidence for both clinical and legal purposes.[20] It is notable that emotional suffering, including chronic anxiety and depression, has an equally profound impact on brain structure and function. Indeed, some of the same brain regions are disrupted in both chronic pain and depression, providing clear biological evidence of the overlap between physical and mental distress.[21]

Other types of mental harm such as Post-Traumatic Stress Disorder (PTSD) can be shown objectively to affect the brain, thereby demonstrating that this emotional injury is also physical in nature. Indeed, one court has so ruled. In the Michigan case *Allen v. Bloomfield Hills School District*, the plaintiff was operating a train when he crashed into a bus that had negligently strayed onto the train tracks. The plaintiff developed PTSD because the crash resulted in the deaths of several schoolchildren. The lower court dismissed his tort claim because the applicable Michigan statute required a showing of "bodily injury," which the court ruled the plaintiff had not proved.[22]

The Court of Appeals reversed the ruling, relying on PET scans of the plaintiff, showing that he had suffered abnormalities in the brain due to the accident.[23] The court noted that "brain injury is a bodily injury."[24] The "plaintiff presented objective medical evidence that a mental or emotional trauma can indeed result in physical changes to the brain. . . . There should be no difference medically or legally between an objectively demonstrated brain injury, whether the medical diagnosis is a closed head injury, PTSD, [or] Alzheimer's Disease."[25] The brain is a part of the body, and hence an injury to the brain that is objectively verifiable should count as physical injury.

The neuroscientific insight that mental pain and harm are sometimes the result of or correlated with brain damage or abnormalities may also play an important role in constitutional jurisprudence addressing American prison systems' practices of prolonged solitary confinement.

At any given time, an estimated one hundred thousand prisoners in this country are held in solitary confinement. Such confinement varies slightly from state to state, but it generally involves a prisoner being kept for approximately twenty-three hours a day alone in a small cell, with minimal social contact and no physical contact with others.[26]

A draconian example of such solitary confinement existed for many years at the Pelican Bay State Prison Security Housing Unit (SHU). At that prison, built in 1989, approximately 1,300 prisoners were imprisoned in small, Spartan, eighty-square-foot cells with no windows for almost twenty-three hours a day. For years, they had no view of the outside world; they saw no birds, trees, cars, or grass.[27] For one-and-a-half hours per day, they went out to a recreation "yard" attached to their cell block. This was a facility about twice the size of their cell, with fifteen-foot-high walls and a grate over the top where they recreated, alone. If they went out to the yard at the right time during the day, it was possible to see a little sunlight, but, generally, most prisoners had only fleeting, if any, glimpses of direct sunlight during their stay at Pelican Bay. They were allowed no phone calls at all except in an "emergency," which was defined as a parent dying, in which case they were allowed a fifteen-minute call with next of kin. They were permitted visits with their family, but no contact visits, meaning they only could speak with their visitors through an intercom, viewing them through a glass window, unable to touch or hug their loved ones. While some had televisions and radi-

os, there was no educational, vocational, or religious programming or activities.[28]

One might think that only the most heinous, pathologically violent prisoners would be placed in these conditions. But, in fact, most of the 1,300 prisoners at the Pelican Bay SHU were not there because of any violent act they had committed in prison, but solely because they were either members or associates (a loose definition that included people who simply associated with members) of a prison gang. These prisoners were placed in the SHU for an indeterminate period of time, which in practice generally meant until the end of their prison terms, unless they were paroled, snitched, or died. In short, the only real way out of the SHU and into the general prison population was to become an informant against the gang, usually a dangerous proposition.

It is hard to imagine surviving in this environment for more than a few days or weeks without becoming suicidal or mentally ill. Some of the prisoners placed in the SHU did become mentally ill. But hundreds did not. It is a testament to the human being's ability to adapt to atrocious conditions that many prisoners were able to survive these conditions not only for weeks, but for decades. As of 2011, almost one hundred of the prisoners at Pelican Bay SHU had been held in solitary confinement for over two decades, and almost five hundred had been so confined for more than ten years. Survival does not, however, mean that they did not suffer serious mental harm: depression, paranoia, and loss of concentration and memory are just some of the symptoms associated with extended solitary confinement.

In 1990, within a year after the Pelican Bay SHU opened, a high-powered and skilled group of lawyers sued the California prison system on behalf of the class of prisoners incarcerated at the Pelican Bay SHU. They drew as the judge who would hear the case one of the most progressive, civil-rights oriented federal judges in the entire country, Thelton Henderson. The case went to trial in 1993, and in early 1995, Judge Henderson ruled that California officials had denied plaintiffs' constitutional rights by using excessive force and by not providing adequate medical care.[29] Yet on the fundamental issue of whether placing prisoners in such strict isolation for years by itself constituted cruel and unusual treatment prohibited by the Eighth Amendment, Henderson did not pull the trigger, even if he did find that the conditions were draconian, sterile, and isolating. For example, he opined that "the overall effect of the SHU is one of stark sterility and unremitting monotony."[30] He found that the conditions of social isolation were profound and noted that when he visited the prison, he observed prisoners pacing around in their cells as if they were animals in a zoo.[31]

The plaintiffs had submitted expert testimony from two internationally prominent psychological experts who had interviewed many prisoners and concluded that they suffered from varying degrees of psychological pain, including paranoia, lack of concentration, chronic depression, confused thought processes, hallucinations, irrational anger, emotional flatness, violent fantasies, and oversensitivity to stimuli.[32] Henderson acknowledged that mental pain, but held that it did not rise to the level of a constitutional violation, stating:

> the record demonstrates that the conditions of extreme social isolation and reduced environmental stimulation found in the Pelican Bay SHU will likely inflict some degree of psychological trauma upon most inmates confined there for more than brief periods. Clearly, this impact is not to be trivialized; however, for many inmates, it does not appear that the degree of mental injury suffered significantly exceeds the kind of generalized psychological pain that courts have found compatible with Eighth Amendment standards.[33]

Henderson did find that for the group of prisoners who were mentally ill or had a history of prior psychiatric problems, placement in the SHU did constitute an Eighth Amendment violation.

> For these inmates, placing them in the SHU is the mental equivalent of putting an asthmatic in a place with little air to breathe. The risk is high enough, and the consequences serious enough, that we have no hesitancy in finding that the risk is plainly "unreasonable." Such inmates are not required to endure the horrific suffering of a serious mental illness or major exacerbation of an existing mental illness before obtaining relief.[34]

Almost twenty years later, in 2011, thousands of prisoners in California went on a hunger strike protesting the conditions at the Pelican Bay SHU and other SHUs around the state. That hunger strike garnered national and international attention and eventually led to a class action lawsuit claiming that incarceration at Pelican Bay for more than ten years was cruel and unusual punishment in violation of the Eighth Amendment.[35] Some of the same prisoners who were at Pelican in the early 1990s were still there in 2011 and were named plaintiffs in the new class action lawsuit.[36]

California responded to the lawsuit by arguing that Judge Henderson had already ruled that the type of psychological pain and suffering that the ordinary, non–mentally ill prisoner suffered at Pelican Bay did not rise to the level of a constitutional violation, and that only harm that resulted in serious mental illness or attempted suicide would be actionable. None of the ten named plaintiffs in the new *Ashker v. Governor* were mentally ill, although they all claimed serious psychological harm. Moreover, they argued that Judge Henderson's ruling had been based on a record of prisoners who had spent two to three years at Pelican Bay, and that he had specifically left open the possibility that more prolonged stays in solitary confinement might violate the Constitution. Henderson could "not begin to speculate on the impact that Pelican Bay SHU conditions may have on inmates confined in the SHU for periods of 10 or 20 years or more; the inmates studied in connection with this action had generally been confined to the SHU for three years or less."[37] Judge Claudia Wilken, who was assigned to hear *Ashker*, rejected California's motion to dismiss the lawsuit, finding it was not precluded by Judge Henderson's decision in *Madrid v. Gomez*.[38]

While *Ashker* proceeded, the plaintiffs still faced the substantial hurdle set by Henderson and other cases that generalized psychological pain such as depression, paranoia, lack of concentration or memory, anger, and hallucinations was insufficient, at least if suffered for only several years, to constitute cruel and unusual punishment. The plaintiffs' team had included top notch psychological experts, one of whom, psychologist Craig Haney, had also testified in the *Madrid* case. Moreover, the plaintiffs' psychological harms seemed even more profound than those recognized in *Madrid* and, the team felt, ought to have been sufficient to establish an Eighth Amendment violation. Nevertheless, the law's general discounting of psychological harm and the Supreme Court's reluctance to recognize familiar modes of punishment as cruel and unusual precluded complacency.

The law concerning prisoners, like the torts jurisprudence discussed above, tends to discount psychological pain and suffering, as did Judge Henderson. While the courts have recognized that psychological harm inflicted by prison officials can constitute an Eighth Amendment violation, Congress enacted a statute, the Prison Litigation Reform Act, that precludes prisoners who suffer constitutional violations from being awarded damages unless they can show that they have suffered

"physical injury" and not purely mental harm.[39] Thus, for example, the Eleventh Circuit Court of Appeals dismissed a damages claim in which prison officials had "ordered prisoners to strip naked, and performed body cavity searches while members of the opposite sex were present; . . . made harassing comments to an inmate because of his perceived sexual orientation; and ordered one prisoner to 'tap dance' while naked."[40] So too, while some courts have held that rape or other sexual assaults constitute a physical injury within the meaning of the Prison Litigation Reform Act, several courts have held that "the bare allegation of sexual assault" does not constitute a physical injury under the statute.[41] Furthermore, when the Senate ratified the Convention on the Prevention of Torture, it added a reservation that mental harm would not count as torture unless it fell within certain narrowly circumscribed exceptions.[42] As it does with tort law, the United States treats mental pain as a second-class citizen for purposes of the international law of torture.

Given the reluctance of the courts and Congress to fully recognize that the mental pain wrought by solitary confinement rises to the level of an Eighth Amendment violation, plaintiffs' counsel sought ways of bringing other sciences and social sciences to demonstrate the harm caused by such conditions. In this case, the science was brought to bear in support of a conclusion that seemed obvious. To hold a person in a small cell with no windows for twenty-three hours a day under crushing conditions of isolation for ten, fifteen, or twenty years must cause serious harm to that individual in a manner that civilized society should not tolerate. As one prominent court of appeals judge has noted, it seems "pretty obvious, that isolating a human being from other human beings year after year or even month after month can cause substantial psychological damage, even if the isolation is not total."[43] Or as Justice Kennedy wrote in a concurring opinion in a case that did not directly challenge the use of solitary confinement, "the human toll wrought by extended terms of isolation has long been understood and questioned by writers and commentators. . . . [R]esearch still confirms what this Court suggested over a century ago. Years on end of near total isolation exact a terrible price."[44]

The plaintiffs' use of neuroscience in the solitary confinement challenge was thus similar to the role neuroscience played in the Eighth Amendment challenge to the execution of juveniles, wherein the Court viewed scientific evidence not as an independent basis for decision, but as evidence that would tend to confirm the conclusion that prolonged solitary confinement caused serious mental and physical harm to the brain to a degree prohibited by the Constitution. As the Court noted in the juvenile death penalty case *Roper v. Simmons*, in distinguishing between adults and juveniles, "as any parent knows, and as scientific and sociological studies respondent and his amici cite tend to confirm, 'a lack of maturity and underdeveloped sense of responsibility are found in youth more often than in adults, and are more understandable among the young.'"[45]

Using neuroscience in the prisoner context, however, faced substantial obstacles. The most important was that neuroscientists had never studied the brains of prisoners and, therefore, no studies directly on point existed. Moreover, the possibility that neuroscientists could do significant scientific studies of the Pelican Bay prisoners was remote. To demonstrate conclusively that solitary confinement alters the brain, a study would have to use one of two types of design. The optimal design would be longitudinal and would require gathering baseline brain imaging data on prisoners before they were placed in solitary confinement followed by periodic testing

to ascertain changes in brain structure and function. To be certain that such changes were associated with isolation and not with prison life in general, similar observations of well-matched control subjects (of similar age, sex, mental ability, and ideally criminal offense history) would have to be taken over the same period of time. An additional control group of subjects equally well-matched on crucial variables but not incarcerated would also be useful since this would enable the parsing of the effects of the general stress of prison life from the additional impact of social isolation, physical inactivity, and other distresses of solitary housing. Absent the basal data, a less optimal cross-sectional design could be used, but it would require a larger number of prisoners in order to enable either the two-way or three-way comparison.

Not only would the cost of doing such a study be massive and untenable for a public interest lawsuit, but even if the necessary funds could be raised, prison officials do not allow scientists into the prison to do studies, and, absent an unlikely court order, the plan would not be workable. Thus, using neuroscience to aid the Court in understanding how prolonged solitary confinement affected the brain required drawing on extant knowledge and theory and extrapolating from what scientists know generally about the brain to the situation in which these prisoners found themselves. This is a second-best solution, but the lawyers thought it would be nonetheless valuable to the Court, even though a more definitive study of the type sketched above was not possible for the purposes of *Ashker v. Brown*.

Despite these obstacles, the *Ashker* lawyers decided to make neuroscience evidence part of their core case for two reasons. First, the Supreme Court has held that to establish an Eighth Amendment violation, a prisoner must show that he or she has been deprived of some basic human need such as food, sleep, or exercise.[46] Court challenges to solitary confinement have sought to add social interaction to the list of basic human needs, and in some cases, have been successful.[47] Neuroscience could aid in establishing that the human brain requires social interaction with other people and, therefore, such interaction is a basic human need. In *Ashker*, the plaintiffs submitted an expert report from neuroscientist Matthew Lieberman, the director of the Social Cognitive Neuroscience Laboratory at the University of California, Los Angeles, and author of the award-winning book, *Social: Why Our Brains Are Wired to Connect*.[48] His declaration explained why social interaction is a basic human need on a par with sleep or exercise. The deprivation of that human need will not – unlike the deprivation of food – result in death in a short order, but like the deprivation of sleep or exercise, it will have very deleterious effects on both mental and physical health over time.

The second reason to introduce neuroscience evidence was to break down the divide between mental and physical pain. The research suggests that solitary confinement would produce physiological changes in the brain, harm that is therefore physical, potentially observable, and causes mental pain. As in the tort context, a demonstration of physiological harm would supplement the psychological research of the harm suffered by individuals who are denied social contact.

Ashker is but one of several cases in which neuroscience has been used to challenge prolonged solitary confinement. As already mentioned, the *Ashker* plaintiffs introduced Lieberman's expert report to support their claims that solitary confinement causes serious mental and physical harms and deprives those confined of the basic human need of social interaction. Lieberman had never studied prisoners nor solitary confinement in state prisons, but he

applied his general research on the effects of social isolation on the brain to the Pelican Bay context.

Lieberman started his report with the proposition that "it is considered settled science within the field of psychology that humans and all mammals have a fundamental need for social connection."[49] Lieberman then described the neuroscientific contribution to understanding social connection as a basic need. He summarized that

> the brain has a neural system that registers various kinds of physical pain – each linked to a potential survival threat (loss of food, water, shelter). . . . My lab and others have observed that when individuals are in a socially deprived state, they experience *social pain* and this produces neural activity consistent with it being a form of pain.[50]

To Lieberman, his neuroscience research, along with the work of others, provides compelling evidence that the social pain of isolation involves "the same neural and neurochemical processes invoked during physical pain."[51] Indeed, fMRI studies that he conducted in collaboration with psychologist Naomi Eisenberger demonstrated that when people were subjected to social isolation, it affected neural activity in certain cortical regions of the brain associated with physical distress, in the same way physical pain would. Lieberman's study has been replicated dozens of times in labs around the world. Lieberman concluded that the social pain caused by isolation is not metaphorical pain, but has a physical effect on brain activity causing the brain to signal distress.[52]

The Amicus Curiae Brief of Medical and other Scientific and Health Related Professionals filed in the United States Supreme Court case of *Ziglar v. Abbasi* also used neuroscience studies to support the proposition that solitary confinement causes both serious psychological and physical harm.[53] The brief cites coauthor Huda Akil for the proposition that neuroscience studies suggest that solitary confinement can "fundamentally alter the structure of the human brain in profound and permanent ways."[54] Akil's view reflects the knowledge that the human brain, like all mammalian brains, alters its structure and functioning based on stimuli from its environment. This process, termed "neuroplasticity," subsumes several mechanisms, including changes in branching or arborization of neurons to enable new connections to neighboring brain cells, changes in activity of certain brain circuits, and, in specialized brain regions, changes in the rate of birth of new neural cells that become embedded in critical circuits.

One region that is very "plastic" is the hippocampus (or seahorse, due to its shape). The hippocampus plays a critical role in handling the interface of the individual with the external world by mapping the physical environment in three dimensions: it sets the level of emotional reactivity and anxiety, it encodes stressful events and controls the body's response to stressors, and it plays a primary role in encoding memories of recent events and determining whether they are destined for long-term storage elsewhere in the brain. These changes are typically adaptive in that they enable the individual to assess a context (physical and emotional), react to it appropriately, and remember it and anticipate future responses. But under conditions of severe and sustained stress, the hippocampus loses this neuroplasticity: it physically shrinks, the rate of birth of new cells diminishes or ceases, the arbors regress, and the opportunity for contacts with neighboring cells decreases. It is therefore not surprising that this brain region begins to fail in its functioning, with loss of emotional and stress control, loss of stress regulation, sometimes defects in memory, spatial orientation, and other cognitive processes, and in extreme cases, last-

ing changes in mood, including severe depression. Moreover, since the brain is highly interconnected, this is but one node of many changes that propagate across the brain and greatly diminish the individual's affective and cognitive functions, resulting in long-term deficits in each.

As argued by Akil in the context of the *amicus* brief, each of the key features of solitary confinement – lack of meaningful interaction with others and the natural world and lack of physical activity and visual stimulation – "is by itself sufficient to change the brain . . . dramatically depending on whether it lasts briefly or is extended."[55] As noted in the brief, many neurobiological studies "reveal that certain regions of the brain of people who experience extreme psychological stress (like those in solitary confinement) literally diminish in volume because the neural cells become shriveled."[56]

A large body of animal studies strongly supports the notion of altered neuroplasticity as a result of an impoverished environment. In a Canadian case, challenging prolonged solitary confinement in British Columbia, the lawyers sought to introduce an expert report from neurologist and animal behavior scholar Michael Zigmond, who noted that the rats and mice that he studies have 99 percent of the same genes as humans and that the basic neuroanatomy of the mouse parallels that of humans.[57] Zigmond reports that his and other studies demonstrate that when mice and rats are randomly grouped into two different environments, one that is enriched with lots of activities and another that is isolated, the rodents in the isolated environment show "enormous differences," such as a "decrease in the anatomical complexity of the brain (including fewer connections between nerve cells and even fewer nerve cells) and a decrease in the number of blood vessels in the brain."[58] These animals also show differences in learning and memory, as well as susceptibility to a range of diseases that emulate human diseases such as Alzheimer's disease, Parkinson's disease, and strokes.[59]

Zigmond concludes that "some of these effects are undoubtedly related to one or more of the biochemical effects of isolation, which include a decrease in the concentration of 'neurotrophic factors' or growth factors that are responsible for the repair of neurons should they begin to atrophy."[60] A key neurotrophic factor is brain-derived neurotrophic factor (BDNF), which modulates diverse functions including learning, memory, navigation, and mood. Similarly, Zigmond has reported that isolation decreases the synthesis of the neurotransmitter dopamine, which is critical for motor function and reward, and the capacity to reduce inflammation and oxidative stress.[61]

Zigmond's most recent and in-depth study showed that brains of isolated rodents have smaller neurons, with fewer branches in the hippocampus and cerebral cortex regions, which affect learning, memory, and executive brain functions.[62] The one region that does show more activity is the amygdala, which mediates fear and anxiety, symptoms reported by human prisoners confined in solitary.

Mice and rats, of course, are not humans, and therefore these studies do not prove that human brains are affected in the same ways as those of rodents.[63] Nonetheless, there are similarities, and the fact that rodents and other mammals react to isolation in a manner that affects their brain functions is some evidence that the human brain is likely to be similarly affected. Thus, this body of work by neuroscientists is not dispositive. But, paraphrasing Justice Kennedy's observation in *Roper v. Simmons*, this research tends to confirm what common experience and years of psychological studies teach us: that prolonged solitary confinement can cause both serious psychological and physiological harm.

One would think it self-evident from a purely ethical perspective that placing a person in a small cell for twenty-three hours a day with very limited or no social contact for years, and sometimes for decades, should not be permitted in civilized society. However, the law requires evidence that such treatment would cause serious harm, and it is in this domain that neuroscience can play an important role in the legal struggle against prolonged solitary confinement. As discussed above, neuroscience is potentially relevant not just to this but to a wide range of other legal issues because an underappreciated and often overlooked contribution that neuroscience can bring to the law is to break down the division that currently exists between physiological and psychological harm and between physical and mental injury. Neuroscience challenges the law's long-unchallenged assumption that most mental suffering is inescapably subjective. Proceeding from the obvious truth that the brain is a physical organ, neuroscience can show empirically and explain theoretically that the brain both regulates and is profoundly affected by mental harm and suffering.

As the interface between neuroscience and the law evolves, several challenges are likely to emerge. While we have underscored the value of neuroscience in providing scientific support for commonsense notions, there will likely be situations in which the opposite happens. Science teaches us that, on occasion, what seem to be obvious truths are incorrect. An example is the widely held belief that children are intrinsically resilient, that they will not remember early life trauma, that they will simply not encode the stress, or that they will readily forget it. However, neurobiological evidence clearly shows that early-life traumatic events, especially if repeated, can produce a lasting deleterious effect on the individual that will manifest later in life. Societal views, as well as legal thought, will likely need to be modified to incorporate such insights.

Moreover, when neuroscience accords with common sense, it may nonetheless provide novel perspectives that may be impactful on legal decisions and legal thought. For example, neuroscience has validated the importance of so-called critical periods during human development when major epigenetic, cellular, and molecular reprogramming can take place in response to environmental conditions, but it has also shown that such key periods are not confined to early childhood. One key period occurs during adolescence. As additional biological evidence accumulates, it will be important for the law to contemplate the implications of such a major biological upheaval, both in understanding human behavior and in dealing with it from a legal standpoint.

Another major challenge stems from the fact that neurobiological changes are rarely binary. Rather, they are incremental, reflecting processes that may wax and wane, and the threshold at which a change becomes deleterious can be difficult to discern. For example, as described above, stress remodels the brain. Some level of remodeling is adaptive and enables coping with further stress, but chronic or severe stress becomes maladaptive, leading to neural damage. However, the point at which a change is likely to be damaging rather than helpful is unclear and varies as a function of the preexisting vulnerability or resilience of any given individual. Moreover, as tools and techniques in neuroscience evolve, our ability to detect changes will improve.

The existence of these continua is not readily compatible with legal formalisms that may classify matters in more binary ways. An example is the notion of competency. As neuroscientists develop more robust biomarkers of cognitive function, it may be possible to detect loss of competency in some functions (such as recall

of recent events) coexisting with maintenance of competency in other brain functions (such as recall of distant events or moral judgment). This may push legal thought toward a more nuanced definition of competency or facets thereof, informed by scientific knowledge.

Our thinking about the ethical, philosophical, and legal implications that arise from the explosion in neuroscience knowledge is in its infancy. It is clear, however, that ongoing discourse between the disciplines will profit both the science and the law, framing questions in interesting ways for the neuroscientist and challenging legal professionals to amend old or develop new conceptual frameworks.

ENDNOTES

[1] Jeffrey Rosen, "The Brain on the Stand," *The New York Times Magazine*, March 11, 2007; Greg Miller, "The Brain Gets Its Day in Court," *The Atlantic*, March 1, 2016; and Nita A. Farahany, "Neuroscience and Behavioral Genetics in U.S. Criminal Law: An Empirical Analysis," *Journal of Law and the Biosciences* 2 (3) (2015): 485–509.

[2] Owen D. Jones, René Marois, Martha J. Farah, and Henry T. Greely, "Law and Neuroscience," *The Journal of Neuroscience* 33 (45) (2013): 17624–17630.

[3] Ibid. See also Owen D. Jones, Jeffrey D. Schall, and Francis X. Shen, eds., *Law and Neuroscience* (New York: Aspen Publishers, 2014).

[4] Shaun Cassin, "Eggshell Minds and Invisible Injuries: Can Neuroscience Challenge Longstanding Treatment of Tort Injuries?" *Houston Law Review* 50 (3) (2013): 929–962; Betsey G. Jones, "The Future of Emotional Harm," *Fordham Law Review* 83 (5) (2015): 2605–2653 [neuroscientific demonstrations that emotional injury occurs with physiological injuries to the brain have begun to impact the legal landscape]; and *Allen v. Bloomfield Hills School District* 760 N.W. 2d 811, 812 (Mich. Ct. App. 2008) [using neuroscientific evidence (a PET scan) to hold that the tort bodily injury requirement was met by injury to the brain].

[5] See Matthew D. Lieberman, expert report, submitted in *Todd Ashker et al. v. Governor of the State of California et al.*, 4:09-cv-05796-CW (N.D. Cal. 2014), https://ccrjustice.org/sites/default/files/attach/2015/07/Lieberman%20Expert%20Report.pdf. See also Craig Haney, Michael Zigmond, Jules Lobel, and Robert King, "Neuroscience in Policy: Solitary Confinement in California," panel at Law and Neuroscience Conference 2017, University of California, San Francisco, and University of California, Hastings, February 16–17, 2017, http://www.ucconsortium.org/events/law-neuroscience-conference-2017/. *Ashker v. Governor* Case No. 4:09-cv-05796-CW was eventually settled in September 2015 in an agreement to release virtually all of the thousands of prisoners being held in indeterminate solitary confinement in California. Ian Lovett, "California Agrees to Overhaul Its Use of Solitary Confinement," *The New York Times*, September 1, 2015.

[6] Jones et al., "Law and Neuroscience," 17624 [see note 2].

[7] David Faigman, "Review: Law and Neuroscience," *Jurimetrics Journal* 56 (2) (2016): 197–200.

[8] Steven J. Morse, "Criminal Law and Common Sense: An Essay on the Perils and Promise of Neuroscience," *Marquette Law Review* 99 (1) (2015): 39–74.

[9] Erin Murphy, "Neuroscience and the Civil/Criminal *Daubert* Divide," *Fordham Law Review* 85 (2) (2016): 619, 629.

[10] *Roper v. Simmons*, 543 U.S. 551, 569 (2004).

[11] Morse, "Criminal Law and Common Sense" [see note 8].

[12] Murphy, "Neuroscience and the Civil/Criminal *Daubert* Divide," 630 [see note 9].

[13] David L. Faigman, Christopher Slobogin, and John Monahan, "Gatekeeping Science: Using the Structure of Scientific Research to Distinguish Between Admissibility and Weight in Expert Testimony," *Northwestern Law Review* 110 (4) (2016): 859 – 904.

[14] Ibid., 887 – 890.

[15] Betsey J. Grey, "Neuroscience and Emotional Harm in Tort Law: Rethinking the American Approach to Free-Standing Emotional Distress Claims," *Law and Neuroscience* 13 (2011): 203.

[16] See Jones et al., "Law and Neuroscience," 935 [see note 2]; and Grey, "Neuroscience and Emotional Harm in Tort Law" [see note 15].

[17] *Hawes v. Germantown Mutual Insurance Company*, 309 N.W. 2d 356, 360 (Wis. Ct. App. 1981).

[18] American Law Institute, *Restatement of the Law Third – Torts: Liability for Physical and Emotional Harm* (Philadelphia: American Law Institute, 2009), Section 4, Comment B ["the definition of bodily harm is meant to preserve the ordinary distinction between bodily harm and emotional harm"].

[19] Ibid., chap. 8, scope, sec. 45 – 48.

[20] Karen D. Davis, Herta Flor, and Henry T. Greely, et al., "Brain Imaging Tests for Chronic Pain: Medical, Legal and Ethical Issues and Recommendations," *Nature Reviews Neurology* 13 (2017): 624 – 638; and A. C. Pustilnik, "Imaging Brains, Changing Minds: How Pain Neuroimaging Can Inform the Law," *Alabama Law Review* 66 (5) (2015): 1099 – 1158.

[21] Alexander J. Shackman, Tim V. Salomons, and Heleen A. Slagter, et al., "The Integration of Negative Affect, Pain and Cognitive Control in the Cingulate Cortex," *Nature Reviews Neuroscience* 12 (2011): 154 – 167.

[22] *Allen v. Bloomfield Hills School District* 760 N.W. 811, 812 (Mich. Ct. App. 2008).

[23] Ibid., 815 – 817.

[24] Ibid.

[25] Ibid., 816.

[26] Sarah Baumgartel, Corey Guilmette, and Johanna Kalb, et al., "Time-in-Cell: The ASCA-Liman 2014 National Survey of Administrative Segregation in Prison," Public Law Research Paper No. 552 (New Haven, Conn.: Yale Law School, 2015).

[27] Keramet Reiter, *23/7: Pelican Bay Prison and the Rise of Long-Term Solitary Confinement* (New Haven, Conn.: Yale University Press, 2016).

[28] Complaint in *Todd Ashker et al. v. Governor of the State of California et al.*, 4:09-cv-05796-CW (N.D. Cal., 2014), https://ccrjustice.org/sites/default/files/assets/Ruiz-Amended-Complaint-May-31-2012.pdf.

[29] *Madrid v. Gomez*, 889 F. Supp. 1146 (N.D. Cal. 1995).

[30] Ibid., 1229.

[31] Ibid.

[32] Ibid., 1231 – 1235.

[33] Ibid., 1265.

[34] Ibid., 1265 – 1266.

[35] See, for example, Lovett, "California Agrees to Overhaul Its Use of Solitary Confinement" [see note 5].

[36] In *Ashker v. Governor*, Todd Ashker, Danny Troxell, and Ronald Dewberry were named plaintiffs who had been at the Pelican Bay SHU since the *Madrid* case was tried.

[37] *Madrid v. Gomez* quoted in Reiter, *23/7*, 1257 [see note 27].

[38] Decision and Order on Defendants' Motion to Dismiss in *Todd Ashker et al. v. Governor of the State of California et al.*, 4:09-cv-05796-CW (N.D. Cal., 2014), 10, https://ccrjustice.org/sites/default/files/assets/Order%20Denying%20Motion%20to%20Dismiss%204.9.13.pdf.

[39] Prison Litigation Reform Act of 1995, Pub. L. No. 104-134, § 803(d), 110 Stat. 1321 (1996), codified as 42 U.S.C. § 1997e(e).

[40] *Harris v. Garner*, 190 F. 3.d 1279, 1282 (11th Cir. 1999).

[41] *Hancock v. Payne*, No. Civ.A.1.03CV671JMRJMR, 2006 WL 21751, at *3 (S.D. Miss. January 4, 2006); and *Smith v. Shady*, No. 3:CV-05-2663,2006 WL 314514, at *2 (M.D. Pa. February 9, 2006). See Margo Schlanger and Giovanna Shay, "Preserving the Rule of Law in America's Jails and Prisons: The Case for Amending the Prison Litigation Reform Act," *University of Pennsylvania Journal of Constitutional Law* 11 (1) (2008): 139 – 154.

[42] U.S. Senate Resolution of Advice and Consent to Ratification of the Convention Against Torture and Other Cruel, Inhuman or Degrading Treatment or Punishment, 138 Cong. Rec. S17486-01 01 (daily ed. October 27, 1990).

[43] *Davenport v. DeRobertis*, 844 F.2d 1310, 1313 (7th Cir. 1988).

[44] *Davis v. Ayala*, 135 S.Ct. 2187, 2209-10 (2005).

[45] *Roper v. Simmons*, 543 U.S. 551, 569 (2004). Emphasis added.

[46] *Wilson v. Seiter*, 504 U.S. 294, 304 (1991).

[47] See, for example, *Wilkerson v. Stadler* 639 F. Supp. 2. 654 (M.D. La. 2007).

[48] Lieberman, expert report [see note 5].

[49] Roy F. Baumeister and Mark R. Leary, "The Need to Belong: Desire for Interpersonal Attachment as a Fundamental Human Need," *Psychology Bulletin* 117 (3) (1995), quoted in Lieberman, expert report, 2 [see note 5].

[50] Ibid., 5.

[51] Ibid., 6.

[52] Ibid., 8 – 9.

[53] 582 U.S. ___(2017). *Ziglar* challenged the conditions under which certain alien arrestees were held in custody following 9/11, including solitary confinement in tiny cells for more than twenty-three hours a day, often in shackles, for as long as eight months. The case, however, was eventually decided on technical legal grounds relating to whether the defendants could be sued for damages under relevant Supreme Court precedent. Thus, the neuroscience arguments advanced by *amici* played no role in the decision, though the arguments further illustrate the relevance of neuroscientific evidence to litigation over conditions of confinement. Supreme Court of the United Sates, "Brief of Medical and Other Scientific and Health-Related Professionals as *Amici Curiae* in Support of Respondents and Affirmance," *Ziglar v. Abbasi*, No. 15-1358, December 23, 2016.

[54] Supreme Court of the United Sates, "Brief of Medical and Other Scientific and Health-Related Professionals as *Amici Curiae* in Support of Respondents and Affirmance," 24 – 25 [see note 53].

[55] Kate Allen, "Researchers Study Effects of Prolonged Isolation Among Prisoners," *The Toronto Star*, February 14, 2014, quoted in ibid., 25.

[56] Supreme Court of the United Sates, "Brief of Medical and Other Scientific and Health-Related Professionals as *Amici Curiae* in Support of Respondents and Affirmance," 25 [see note 53].

[57] See Expert Report of Michael J. Zigmond, *British Columbia Civil Liberties Association and the John Howard Society of Canada v. Attorney General of Canada*, SCBC Vancouver Registry No. S-150415 (February 22, 2017), 2 [report was rejected by the Canadian Court and not admitted into evidence]. See also Ramin Skibba, "Solitary Confinement Screws Up the Brains of Prisoners," *Newsweek*, April 18, 2017.

[58] Zigmond, "Isolated Housing of Non-Human Animals," 7 – 8 [see note 57].

[59] Ibid., 8.

[60] Ibid.

[61] Ibid.

[62] Skibba, "Solitary Confinement Screws Up the Brains of Prisoners," 52 [see note 57].

[63] Indeed, the Canadian Court rejected the Zigmond declaration on the grounds that animal-based evidence could not be extrapolated to humans.