Introduction

Shari Seidman Diamond & Richard O. Lempert

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,

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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.

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

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[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.