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OVERCOMING JUDICIAL INNUMERACY: A PROPOSAL TO BRING THE VENERABLE PROCESS OF PEER REVIEW TO THE ENDURING PROBLEM OF COURTS' SCIENTIFIC ILLITERACY

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ABSTRACT

Lawyers are not known for their proficiency in math and science. Most of us who went to law school reached a point in our math and science studies when we realized that neither medicine nor engineering were likely to be successful career paths. It is these lawyers who become judges. Yet, the United States Supreme Court has increasingly put the burden for deciding complex scientific and technical questions in the hands of judges.

This Article explores this trend of putting greater responsibility for deciding scientific and technical issues on judges, particularly in the areas of evidence law, administrative law, and constitutional law. I do not, however, uniformly decry this trend. In many contexts, both as a matter of legal doctrine and as an empirical matter, judges are the appropriate decision makers for scientific and technical questions. The problem is that they, on the whole, are so unqualified for this task.

The question, then, is how courts might be better prepared to make informed decisions about scientific and technical questions. I propose a solution that comes from the scientific enterprise itself, peer review. While not a perfect solution, peer

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review has proved to be the best available option for evaluating the validity and value of scientific research. I explore how a formal procedure of peer review might be employed by courts to provide them with independent assessments of expert reports.

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> "I had been to school most all the time, and could spell, and read, and write just a little, and could say the multiplication table up to six times seven is thirty-five, and I don't reckon I could ever get any further than that if I was to live forever. I don't take no stock in mathematics, anyway."
>
> —Huckleberry Finn[1]

I. INTRODUCTION

Like Huck Finn, lawyers generally do not aspire to proficiency in math and science. Indeed, for a college student with straight As in Russian Literature, law school is likely near the top of the list of career advice. For STEM majors, law

[1] MARK TWAIN, THE ADVENTURES OF HUCKLEBERRY FINN 22 (University of California Press 1985).

school is well down such a list.[2] In effect, lawyers, as a group, suffer from a selection bias against scientific literacy.[3] And it is these lawyers who become judges.

Yet, the United States Supreme Court has increasingly put the burden for deciding complex scientific and technical questions in the hands of judges.[4] This trend is manifest in multiple areas, including especially the areas of evidence law,[5] administrative law,[6] and constitutional law.[7] In all three of these areas, however, courts have repeatedly demonstrated their inability to understand basic principles

[2] *See* Karen Sloan, *College students with these majors crush the LSAT. End of logic games may change that.*, REUTERS (June 4, 2024), https://www.reuters.com/legal/legalindustry/college-students-with-these-majors-crush-lsat-end-logic-games-may-change-that-2024-06-04/ [https://perma.cc/4BSK-J7PW] ("Fewer than 5,000 STEM majors applied to law school in 2023—just 6.6% of the national applicant pool, according to data from the Law School Admission Council. More than 50,000 arts and humanities or social sciences majors applied.").

[3] Although the focus of this Article is principally on scientific literacy, the principal title calls out judges' "innumeracy." Of course, while scientific literacy might begin with innumeracy, much more is involved in understanding and consuming scientific knowledge. Thomas Huxley famously said that "science is . . . nothing but trained and organized common sense." THOMAS HENRY HUXLEY, ON THE EDUCATIONAL VALUE OF THE NATURAL HISTORY SCIENCES 12 (J. Van. Voorst 1854). Knowing how that common sense is applied, however, is unfortunately too uncommon in the law. Beyond competence in statistics, such a knowledge base requires understanding multi-layered concepts such as hypothesis testing and research methods and design. Hence, while innumeracy might be the cornerstone of scientific illiteracy—and, indeed, likely what drove many law school applicants out of careers in science—much more than basic numeracy is needed for judges to become sophisticated consumers of science.

[4] The phenomenon of judges' increased responsibility for empirical issues extends beyond science, especially in constitutional cases. For instance, the doctrine of original intent requires judges to also be historians. *See generally* Joseph Blocher & Brandon L. Garrett, *Originalism and Historical Fact-Finding*, 112 GEO. L.J. 699 (2024); Ryan C. Williams, *Historical Fact*, 99 NOTRE DAME L. REV. 1585 (2024); Alexandra Michalalk, *Historians Wear Robes Now? Applying the History and Tradition Standard: A Practical Guide for Lower Courts*, 32 WM. & MARY BULL RTS. J. 479 (2023); Daniel Farber, *Adjudication of Things Past: Reflections on History as Evidence*, 49 HASTINGS L.J. 1009 (1998).

[5] *See* David L. Faigman, *The Law's Scientific Revolution: Reflections and Ruminations on the Law's Use of Experts in Year Seven of the Revolution*, 57 WASH. & LEE L. REV. 661, 661 (2000).

[6] *See* Loper Bright Enters. v. Raimondo, 144 S. Ct. 2244, 2267 (2024), and discussion *infra* notes 32, 65-79.

[7] *See* Joseph Blocher & Brandon L. Garrett, *Fact Stripping*, 73 DUKE L.J. 1, 11 (2023) (arguing that "doctrines crafted by the Supreme Court, tying facts to questions of constitutional interpretation and generally arrogating power to itself—sometimes in the face of procedural rules and constitutional rights that would otherwise counsel deference to lower court factfinding.").

of science.[8] In an increasingly technological society, rules of law depend on empirical premises. Ignorance of science thus results in poor legal outcomes.[9]

I do not, however, uniformly decry the judiciary's increasing appropriation of authority over fact-finding. Many empirical questions that judges now take onto themselves belong there. Others do not. My ultimate complaint is not so much that judges have assumed greater responsibility to decide empirical questions, but that they are so profoundly unqualified for the task. While there are notable exceptions, courts' integration of scientific precepts into the procedures and substance of the law is superficial and elementary. Application of the inherent complexities of scientific research requires knowledge of the culture, dynamics, language, and limitations of scientific discovery. Courts have largely failed to demonstrate the literacy necessary for this task.

Many commentators on judicial fact-finding begin with the similar premise that judges are largely scientifically illiterate, a premise that drives them to urge that other decision makers, whether they be juries, legislators, or administrators, should evaluate fact-based scientific propositions instead.[10] Beyond the obvious question of whether these other decision makers could do any better, this approach ignores more fundamental considerations. The more immediate question is whether the law, or good policy, make fact-finding essential to the judicial role. Answers to this question depend on both the demands of legal doctrine, including not least constitutional considerations, as well as an understanding of the nature of scientific discovery. Overlooked in many examinations of judicial responsibility for fact-finding is the nature of the facts that need to be found.

In this Article, I explore two separate but interrelated issues. The first asks: What principles define the division of responsibilities between judges and other

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[8] The innumeracy extant among judges appears to be a truism, one that many scholars have commented on and none refute. *See, e.g.*, Daubert v. Merrell Dow Pharms., Inc., 43 F.3d 1311, 1316 (9th Cir. 1995) ("As we read the Supreme Court's teaching in *Daubert*, therefore, though 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 amounts to 'scientific knowledge,' constitutes 'good science,' and was 'derived by the scientific method.'"); United States v. Cline, 188 F. Supp. 2d 1287, 1294 (D. Kan. 2002) ("Those of a 'scientific' bent certainly can take issue with whether the judges and lawyers have the education or training to engage in 'scientific' testing . . . ."); *see generally* Shawn Kolitch, *Constitutional Fact Finding and the Appropriate Use of Empirical Data in Constitutional Law*, 10 LEWIS & CLARK L. REV. 673 (2006) (discussing inconsistent and flawed use of empirical data by the Supreme Court); Sheldon Whitehouse, *Knights-Errants: The Roberts Court and Erroneous Fact-Finding*, 84 OHIO STATE L.J. 837 (2024) (discussing improper fact-finding by the Supreme Court).

[9] There are, of course, many areas of law that present technically challenging material to judges, including in particular the areas of intellectual property and the use of mathematical algorithms in law enforcement. The discussion below largely applies to those areas as well, as does my proposed solution.

[10] *See, e.g.*, Caitlin E. Borgmann, *Appellate Review of Social Facts in Constitutional Rights Cases*, 101 CAL. L. REV. 1185, 1248 (2013) ("The best way to ensure that facts are examined dispassionately and deliberately is through the adversarial process of a trial. Where such facts are determinative of a law's constitutionality, trial courts should hold trials testing the facts, and their findings should receive a presumption of finality.").

decision makers for deciding factual matters? In examining this question, I consider both the nature of the factual issue presented and the principles of law that allocate responsibility for factual decisions among possible decision makers. I limit my inquiry to scientific evidence[11] and concentrate on the areas of evidence law, administrative law, and constitutional law to examine these issues. The second follows from the first: If judges are often the appropriate deciders of scientific questions, how might they successfully fulfill that responsibility? I propose a solution that comes from the scientific enterprise itself – peer review.[12]

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[11] Fact finding in the law includes many areas that are not "scientific" or amenable to scientific testing. Indeed, the whole question of what qualifies an empirical proposition as science is the subject of volumes in the philosophy of science. *See, e.g.*, KARL POPPER, THE LOGIC OF SCIENTIFIC DISCOVERY 1-26 (Routledge 2002); THOMAS KUHN, THE STRUCTURE OF SCIENTIFIC REVOLUTIONS 1-9 (50th Anniversary ed. 2012). Courts too have contemplated the nature of scientific inquiry. *See, e.g.*, Daubert v. Merrell Dow Pharms., Inc., 509 U.S. 579, 593 (1993) ("Ordinarily, a key question to be answered in determining whether a theory or technique is scientific knowledge that will assist the trier of fact will be whether it can be (and has been) tested."). For present purposes, I limit my scope to opinion testimony that rests, or should rest, on testable—that is, verifiable—empirical premises. *See id.* ("[T]he criterion of the scientific status of a theory is its falsifiability, or refutability, or testability.") (citing KARL POPPER, CONJECTURES AND REFUTATIONS: THE GROWTH OF SCIENTIFIC KNOWLEDGE 37 (5th ed. 1989)). The Court's turn toward philosophy of science has not been without controversy. *See* David Crump, *The Trouble with Daubert-Kumho: Reconsidering the Supreme Court's Philosophy of Science*, 68 MO. L. REV. 1, 1-3 (2003); *see also* Susan Haack, *Federal Philosophy of Science: A Deconstruction—and a Reconstruction*, 5 N.Y.U. J.L. & LIBERTY 394, 394-99 (2010).

While the discussion in the next section of this article focuses on scientific evidence, in regard to dividing fact-finding responsibility between courts and other possible decision makers, the solution proposed in the section thereafter does not depend on a scientific label for the evidence. Many other kinds of facts might be conducive to the solution of peer review proposed here, including especially historical. Most academic disciplines use peer review to vet manuscripts before publication. However, given that much of the discussion here is devoted to the nature of the fact-finding involved as it concerns allocating responsibility among prospective fact-finders, I limit my analysis to science, since findings therein share certain common denominators.

[12] I first explored the possibility of bringing peer review to the courts in David L. Faigman, *Bringing Scientific Peer Review to Scientific Evidence*, 52 ARIZ. ATT'Y 20 (2016). This early exploration eventually led to my founding a company with Dr. Amit Lakhani to operationalize some of the ideas presented there and set forth *infra*. The company, JuriLytics, LLC, provided peer review of expert reports to attorneys and judges, but eventually went out of business in 2020, during the pandemic. JuriLytics, PITCHBOOK, https://pitchbook.com/profiles/company/119896-03#overview [https://perma.cc/272U-J7SF] (last visited Mar. 18, 2025).

Although the service was well received by some attorneys, many preferred to receive feedback that supported their litigation position, rather than receive views on the state of the art of the science that might be contrary to what they planned to argue in court. Judges were also somewhat reluctant to use the service, but for other reasons. Several told me that they were disinclined to hire a for-profit company but would likely welcome the service if offered by a non-profit entity. The discussion below reflects many of the lessons learned in this earlier effort. One case that the company worked on for a Mississippi trial court reached that state's supreme court, where the service was positively noted. *See* T.L. Wallace Constr., Inc. v. McArthur, Thames, Slay, & Dews, PLLC, 234 So. 3d 312, 325 (Miss. 2017) ("The trial court, pursuant to Mississippi Rule of Evidence 104(a), appointed JuriLytics, LLC, as a technical advisor to the court. JuriLytics, based out of California, provides courts and attorneys with high-level academic peer review of expert reports. JuriLytics provided two independent reviews of each parties' reports on issues surrounding auditing standards and two independent reviews on issues surrounding causation and damages.").

The law has long championed the inherent wisdom of employing the adversarial process to resolve disputes.[13] That is true for the three areas considered here. Whatever the efficiency of the adversarial process more generally for dispute resolution, it is not well suited in the domain of scientific disagreements. This is especially so for judges not sufficiently informed to evaluate such disagreements. A principal question, therefore, must ask: If judges have substantial responsibility to adjudge scientific disagreements but currently lack the knowledge base to do so effectively, how might they compensate for this deficiency? There are several possibilities. For instance, judges could become better trained in science. This is a solution that, however virtuous, is deeply unlikely. For many judges, law school was the antidote to math and science phobia. Another solution touted by many is for judges to make greater use of court-appointed experts[14] or technical advisers.[15] But judges' devotion to the adversarial process leads most of them away from such a seemingly judicious solution.[16] Many other suggestions have been made, from special science courts to special masters.[17] Most of these run up against objections largely involving the virtues of the adversarial process. Any solution, then, must somehow provide judges with state of the art science, while not treading too heavily on the adversarial process. Peer review provides that solution.

In the next section, Section II, I consider the extent to which judges are, and should be, responsible for understanding the nuts and bolts of scientific research. This analysis indicates that very often the law and the nature of the relevant empirical issue, either separately or together, make judges appropriate fact-finders. Given the significant need for judges to understand the science and technology that enters the courtroom, Section III advances a solution to help them accomplish this task. The proposal, however, is neither new nor novel. I propose the age-old process of peer review as a solution to the age-old problem of judicial innumeracy.

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[13] *See, e.g.*, Borgmann, *supra* note 10.

[14] *See, e.g.*, Joe S. Cecil & Thomas E. Willging, *Accepting* Daubert's *Invitation: Defining a Role for Court-Appointed Experts in Assessing Scientific Validity*, 43 EMORY L.J. 995, 995-96 (1994); Samuel R. Gross, *Expert Evidence*, 1991 WIS. L. REV. 1113, 1220 (1991) ("The most appealing solution to the problem of partisan expert evidence is still the oldest: use court-appointed experts.").

[15] *See, e.g.*, Conservation Law Foundation v. Evans, 203 F. Supp.2d 27, 30 (D.D.C. 2002) ("[T]he Court has determined that a technical advisor is necessary to teach and instruct the Court. It is important to note that the Court is appointing an expert technical advisor, not an expert witness pursuant to FED. R. EVID. 706."); Association of Mexican-American Educators v. California, 231 F.3d 572, 593 (9th Cir. 2000) (upholding use of technical advisers under FED. R. EVID. 104(a)).

[16] *See* Cecil & Willging, *supra* note 14, at 1018-19 (noting that a key objection to the use of court-appointed experts is the judiciary's commitment to the adversarial system).

[17] *See, e.g.*, Wayne D. Brazil, *Special Masters in Complex Cases: Extending the Judiciary or Reshaping Adjudication*, 53 U CHI. LAW REV. 394, 394, (2016); Stephen Breyer, *Science in the Courtroom*, ISSUES IN SCI. & TECH. (Summer 2000), https://issues.org/breyer-science-courtroom/ [https://perma.cc/RW4U-5G8H].

II. AT THE INTERSECTION OF LAW AND SCIENCE

Although evidence law, administrative law, and constitutional law are disparate legal domains, there are scientific and legal principles that arise commonly across them that are relevant to the division of responsibility for deciding scientific questions. These involve basic considerations regarding the nature of science and principles of law.

A detailed dissertation on how best to identify the border between "law" and "fact" in the three broad areas considered here is well beyond the scope of the present effort. Nonetheless, a common denominator can be identified in matters of "law": They transcend individual disputes and have broad implications beyond the individual case. Many scientific issues that courts consider routinely share this characteristic of transcending individual cases. Scientific questions such as the developmental capacities of minors, the medical and psychological implications for children receiving gender-affirming care, the cancerous effects of glyphosate, or the effects of ozone on people with asthma have broad legal and policy consequences. Such factual matters are thus like law and are amenable to being treated similarly.[18] At the same time, other aspects of scientific fact-finding have few consequences beyond the individual case. While undeniably important, questions such as whether a particular minor-defendant is developmentally mature, whether a particular child should be entitled to receive gender-affirming medical care, or the plaintiff's leukemia was caused by glyphosate, or whether an asthmatic person will suffer because of high ozone levels, do not have the same broad societal relevance.

Hence, where the scientific enterprise interacts with the enterprise of the law, the varying natures of these endeavors implicate difficult questions of how best to divide responsibility for deciding scientific disputes. I turn to this issue next.

A. The Nature of Science in Law

Legal scholarship and judicial decisions have long recognized the distinction between facts of general importance and facts specific to a particular case. This distinction was famously made by Kenneth Culp Davis's classification distinguishing legislative and adjudicative facts.[19] According to Davis, legislative

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[18] John Monahan & Laurens Walker, *Social Authority: Obtaining, Evaluating, and Establishing Social Science in Law*, 134 U. PA. L. REV. 477, 477-79 (1986) (discussing the historical treatment of social science in the law); *see also* Ronald J. Allen & Michael S. Pardo, *The Myth of the Law-Fact Distinction*, 97 NW. U. L. REV. 1769, 1770 (2003) (discussing complexities leading to certain conclusions being deemed "factual" and others "legal").

[19] Kenneth Culp Davis, *An Approach to Problems of Evidence in the Administrative Process*, 55 HARV. L. REV. 364, 402 (1942). As reflected in this Article, Davis's approach has had impact well beyond the administrative process. *See, e.g.*, FED. R. EVID. 201(a) advisory committee's notes on proposed rules ("Legislative facts . . . are those which have relevance to legal reasoning and the lawmaking process, whether in the formulation of a legal principle or ruling by a judge or court or in the enactment of a legislative body.").

facts have relevance to legal reasoning and the fashioning of legal rules. Adjudicative facts are relevant to the resolution of particular cases. Davis explained:

> Adjudicative facts usually answer the questions of who did what, where, when, how, why, with what motive or intent…. Legislative facts do not usually concern the immediate parties but are general facts which help the tribunal decide questions of law and policy and discretion.[20]

Although Davis's categorization has been extraordinarily influential, it does not fully capture the true nature of scientific discovery. Unlike the law's need to find facts both generally and specifically, scientists work almost exclusively at the group or population level. Whether the hypothesis concerns violent people or violent storms, scientists study groups to identify the probability that people or storms will be violent and the factors that inform such predictions. In many cases, in contrast, courts must determine facts in individual cases. In a toxic tort litigation, for instance, the initial question might be whether glyphosate can cause leukemia in those exposed to certain dosages.[21] The ultimate legal issue, however, is the very different statistical problem of whether glyphosate caused the plaintiff's leukemia. Whereas scientists study phenomena at the group (G) level, judicial questions often must be resolved at the individual (i) level. This is the problem of G2i, which is inherent across the broad intersection of law and science.[22]

G2i is endemic to fact-finding across the three domains of evidence, administrative, and constitutional law. In evidence law, virtually all—if not all—scientific issues present G2i challenges. In toxic tort cases, for instance, research might indicate a relationship between Seroquel (an antipsychotic drug) and diabetes,[23] but determining that a plaintiff's diabetes is attributable to having taken the drug is a highly complicated exercise in statistical inference.[24] Similarly, eyewitness identifications may generally be less accurate when the observer is a different race from the observed,[25] but determining that a particular cross-race identification was inaccurate does not necessarily follow directly from this general finding.

In administrative law, scientific fact-finding occurs both in agencies' rulemaking and in their adjudication capacities. But it manifests somewhat

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[20] KENNETH CULP DAVIS, ADMINISTRATIVE LAW TEXT §7.03, at 160 (3d ed. 1972).

[21] *See In re* Roundup Prods. Liab. Litig., 390 F. Supp. 3d 1102, 1113 (N.D. Cal. 2018), *aff'd sub nom.* Hardeman v. Monsanto Co., 997 F.3d 941 (9th Cir. 2021) ("It's enough in this litigation, at this stage, for the plaintiffs to show that glyphosate can cause NHL when people are exposed to the highest dose people might plausibly experience.").

[22] David L. Faigman, John Monahan & Christopher Slobogin, *Group to Individual (G2i) Inference in Scientific Expert Testimony*, 81 U. CHI. L. REV. 417, 419-21 (2014).

[23] *See, e.g.*, Guinn v. AstraZeneca Pharma., 602 F.3d 1245, 1257 (11th Cir. 2010) (affirming exclusion of expert testimony on the basis of specific causation).

[24] Joseph Sanders, David L. Faigman, Peter B. Imrey & Philip Dawid, *Differential Etiology: Inferring Specific Causation in the Law from Group Data in Science*, 63 ARIZ. L. REV. 851, 853-57 (2021).

[25] *See, e.g.*, ELIZABETH F. LOFTUS, EYEWITNESS TESTIMONY 136-37 (1979); Gary L. Wells and Elizabeth A. Olson, *Eyewitness Testimony*, 54 ANN. REV. PSYCH. 277, 280-81 (2003).

differently in these two contexts. Most of the scientific issues presented around rulemaking are general in kind and don't involve application to individual cases. However, as reflected in the fact that Kenneth Culp Davis was writing about administrative law when he first described the distinction between legislative and adjudicative fact, much of agencies' responsibilities include adjudicating individual claims involving agencies, ranging from the Social Security Board to the Securities and Exchange Commission.[26] Although much of the fact-finding in agency adjudication is limited to historical facts—such as whether a claimant has a qualifying disability or a filing contains a material misstatement—an overwhelming number fully parallel the G2i framework applicable to ordinary judicial proceedings.[27]

Constitutional law aligns with this same G2i structure. Whether seventeen-year-old defendants are as developmentally competent for Eighth Amendment sentencing purposes as eighteen-year-olds was answered in the negative in *Roper v. Simmons*,[28] in which the Court relied on, among other things, available behavioral psychology.[29] However, as the Court made clear in subsequent cases , when sentencing particular defendants, a court must determine the developmental competencies of those individuals being sentenced.[30]

While scientific evidence presents itself similarly in evidence, administrative, and constitutional law, these areas involve arguably very different legal principles regarding how responsibility for deciding scientific questions should be allocated

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[26] *See* Davis, *supra* note 19, at 365 (noting, in this context, "the Social Security Board, the Veterans' Administration, and the Railroad Retirement Board").

[27] Although Davis limited his classification scheme to legislative and adjudicative facts, he well understood the general nature of some agency fact-finding and its relation to adjudicating individual cases. For Davis, this issue primarily involved agencies employing their expertise about general science when deciding a case. For instance, he queried:

> In a workmen's compensation case an employee does some unusually heavy work, and several hours later feels a sudden pain in his groin. The only doctor who gives expert testimony says that in this type of inguinal hernia no pain would be felt at the time of the injury because the pain results only from the later bulging through the area which has been torn or weakened. The commission, having handled dozens of such cases before, having heard testimony of many doctors on the point, having read numerous excerpts from medical treatises, and having consulted with medical members of its own staff, decides that the hernia would be accompanied by pain at the time of its occurrence and accordingly that it did not arise out of employment. Is the commission taking official notice or is it exercising its judgment in interpreting the facts and drawing inferences of fact? Should the commission be permitted to draw upon its general understanding of medical facts concerning inguinal hernia and reach a conclusion directly contrary to the only medical testimony in the record?

Davis, *supra* note 19, at 417.

[28] *See* Roper v. Simmons, 543 U.S. 551, 578 (2005).

[29] *Id*. at 570 (observing that psychological and behavioral "differences render suspect any conclusion that a juvenile falls among the worst offenders").

[30] *See, e.g.*, Miller v. Alabama, 567 U.S. 460, 479-80 (2012) (holding that mandatory LWOP for a juvenile who committed a homicide was unconstitutional but also that this extreme sentence could be imposed on a case-by-case basis).

among possible fact-finders. Resolving these allocations largely depends on principles of law in the respective areas that divide responsibility between possible decision makers such as judge/jury, judge/agency, trial judge/appellate judges, legislature/judiciary, and so forth. The next section examines some of these considerations.

B. Managing Science Across Legal Domains

The allocation of responsibility for deciding matters of scientific evidence are primarily domain-specific. In evidence law, the Federal Rules of Evidence and state evidence codes ostensibly allocate the responsibility of deciding admissibility to judges and of deciding weight to fact-finders.[31] Although administrative law is in a time of transition, the basic issue of dividing authority between Article II administrators and Article III courts in the shadow of Article I legislators remains. In constitutional cases, allocating authority for resolving evidentiary questions inevitably implicates the courts' responsibility to say what the law is.[32]

1. Evidence Law

Some scholars have argued that the right to a jury guaranteed by the Sixth and Seventh Amendments should place the determination of evidentiary questions, such as expert testimony, with jurors.[33] However, these amendments have never been interpreted so literally, for such a view would render all exclusionary rules of evidence unconstitutional. The division of responsibility between judge and jury for decisions regarding evidence is a pragmatic one, driven primarily by the insight that permitting jurors unregulated access to all relevant evidence introduced by the parties would overwhelm, confuse, and unfairly prejudice them.[34] It is commonplace to say that judges decide admissibility and juries decide what weight to put on admitted evidence. But this description of job duties alone provides little

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[31] *See, e.g.*, FED. R. EVID. 104(A) ("The court must decide any preliminary question about whether . . . evidence is admissible."); CAL. EVID. CODE § 310 (2024) ("[T]he admissibility of evidence . . . [is] to be decided by the court."); CAL. EVID. CODE § 312 (2024) ("Subject to the control of the court, the jury is to determine the effect and value of the evidence addressed to it, including the credibility of witnesses and hearsay declarants.").

[32] This section largely avoids taking a position on the wisdom under legal principles for the allocation of fact-finding authority. For instance, as discussed *infra* Section II.B.2, *Loper Bright Enters. v. Raimondo* shifted the responsibility for significant aspects of fact-finding in administrative law from technically proficient agencies to less technically proficient courts. 144 S. Ct. 2244, 2267 (2024). Just on the basis of comparative expertise alone, this move seems unwise. Nonetheless, this move aligns with the thesis of this Article and, in particular, my concern with how courts might seek to buttress their management of this responsibility.

[33] *See* Brandon L. Boxler, *Judicial Gatekeeping and the Seventh Amendment: How Daubert Infringes on the Constitutional Right to A Civil Jury Trial*, 14 RICH. J.L. & PUB. INT. 479, 481 (2011) (arguing "that the creation of judicial gatekeeping has caused an institutional shift of adjudicatory authority away from juries and into the hands of judges in violation of the Seventh Amendment").

[34] *See* JAMES BRADLEY THAYER, A PRELIMINARY TREATISE ON EVIDENCE AT THE COMMON LAW 509 (1898) (finding the law of evidence "a piece of illogical, but by no means irrational, patchwork; not at all to be admired, nor easily to be found intelligible, except as a product of the jury system") (cited and quoted in Davis, *supra* note 19, at 371).

guidance. The ultimate rule of evidence law is that all relevant evidence is admissible unless there is a good reason to exclude it. The rules of evidence compile all of the good reasons to keep relevant evidence from jurors.[35]

In *Daubert v. Merrell Dow Pharmaceuticals, Inc*.,[36] the Court held that judges are gatekeepers, and they must ensure that proffered scientific evidence under Federal Rule of Evidence 702 is legally relevant and scientifically valid.[37] The Court famously offered lower courts five guiding principles by which to evaluate the validity of the research basis underlying proffered scientific evidence. These include whether the methods and principles underlying the testimony are testable and have been adequately tested, have acceptable error rates, were peer-reviewed and published, have adequate standards controlling the procedure or technique, and are generally accepted in the pertinent field.[38] Unfortunately, these factors quickly became a talisman for lower courts, to be recited but rarely substantively applied.[39]

Chief Justice Rehnquist wrote separately in *Daubert*, concerned that the gatekeeping role envisioned by the majority would require judges to become "amateur scientists."[40] While perhaps it did, judges largely resisted doing so.[41] In fact, there was substantial confusion following the decision regarding what demands it placed on judges. This confusion revolved around whether *Daubert* was meant to be permissive or restrictive in its approach to expert evidence.[42] To a large extent, later developments were ostensibly intended to clarify this debate.

The first issue the Court needed to address concerned the applicable standard of appellate review to a trial court's Rule 702 decisions. In *General Electric Co. v. Joiner*, [43] the Court approached this question conventionally, believing that scientific evidence was like other evidence, such that the ordinary standard of abuse of discretion should apply.[44] The next issue the Court confronted was whether the gatekeeping requirement found in *Daubert* applied to non-scientific expert

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[35] FED. R. EVID. 403.

[36] 509 U.S. 579, 597 (1993).

[37] *Id*.

[38] *Id*. at 593-95.

[39] *See* David E. Bernstein & Eric G. Lasker, *Defending* Daubert: *It's Time to Amend Federal Rule of Evidence 702*, 57 WM. & MARY L. REV. 1, 6 (2015).

[40] Daubert v. Merrell Dow Pharms., Inc., 509 U.S. 579, 600-01 (1993) (Rehnquist, C.J., dissenting) ("I do not doubt that Rule 702 confides to the judge some gatekeeping responsibility in deciding questions of the admissibility of proffered expert testimony. But I do not think it imposes on them either the obligation or the authority to become amateur scientists in order to perform that role.").

[41] David L. Faigman, *Judges as "Amateur Scientists*," 86 BOSTON U. L. REV. 1207, 1208-09 (2006).

[42] This confusion regarding what *Daubert* had wrought was evident even within federal circuits. *Cf.* Cavallo v. Star Enterprise, 892 F. Supp. 756, 774 (E.D. Va. 1995) ("*Daubert* assigned district courts a more vigorous role to play in ferreting out expert opinion not based on the scientific method."), *with In re* Lipitor (Atorvastatin Calcium) Mktg., 892 F.3d 624, 632 (4th Cir. 2018) ("Rule 702 was intended to liberalize the introduction of relevant expert evidence.").

[43] 522 U.S. 136 (1997).

[44] *Id*. at 146-47.

testimony, specifically Rule 702's application to "technical or other specialized knowledge." Since *Daubert* was merely interpreting the plain meaning of Rule 702, the Court in *Kumho Tire Co. v. Carmichael*[45] readily found that the rule drew no distinction between "scientific, technical, or other specialized knowledge."[46] Hence, the gatekeeping obligation applied to all testimony offered under Rule 702.[47]

Despite the fact that the *Daubert* trilogy was an exercise in statutory interpretation,[48] Rule 702 was amended in 2000 to reflect these decisions. Nonetheless, courts struggled in the ensuing years to give meaning to Rule 702, with many hardly mentioning the rule and instead continuing to cite *Daubert* as controlling law.[49] This failure is likely a vestige of courts' discomfort with weighing in on the details of scientific research. Whatever the cause of courts' ignoring the applicable rule, Rule 702 was again amended in 2023 to reinforce for courts that it, not *Daubert*, is the controlling authority.[50]

Although the amended Rule 702 demands judges refocus on their responsibilities as gatekeepers, their success largely depends on their better understanding of the nature of scientific research relevant to this role. This requires an appreciation of G2i. The G2i problem is plainly presented in ordinary cases, both civil and criminal. Whereas scientists study groups or populations, the ultimate issue in many cases is specific to the case at-hand. Hence, for example, jurors must decide whether the cartridge case found at the crime scene is unique to a gun associated with the defendant. Firearms identification experts would gladly provide such individualization, routinely testifying that the cartridge case came from the suspect gun to the practical exclusion of all other guns in the world.[51] Research does not support such categorical claims.[52] Similarly, in toxic tort cases, the jury must find that the alleged substance caused the plaintiff's particular illness. This requires proof that the substance can cause the illness (referred to in medical causation cases as "general causation") and that it more likely than not *did* cause

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[45] 526 U.S. 137 (1999).

[46] *Id*. at 147.

[47] *Id*.

[48] *See* Daubert v. Merrell Dow Pharms., Inc., 509 U.S. 579, 586 (1993) ("We interpret the legislatively enacted Federal Rules of Evidence as we would any statute.").

[49] *See* Bernstein & Lasker, *supra* note 39, at 8 ("[A] number of courts have simply ignored the Rule 702 amendment, relying instead on *Daubert* case law prior to the amendment or even on case law prior to *Daubert* itself.").

[50] *See* FED. R. EVID. 702 advisory committee's notes on 2023 amendment ("But many courts have held that the critical questions of the sufficiency of an expert's basis, and the application of the expert's methodology, are questions of weight and not admissibility. These rulings are an incorrect application of Rules 702 and 104(a).").

[51] *See, e.g.*, United States v. Otero, 849 F. Supp. 2d 425, 431 (D.N.J. 2012) (upholding examiner's testimony relying on theory that finding "sufficient agreement exist[ing] between two toolmarks means that the agreement is of a quantity and quality that the likelihood another tool could have made the mark is so remote as to be considered a practical impossibility.") (internal quotations omitted).

[52] *See* Michael J. Saks & Jonathan J. Koehler, *The Individualization Fallacy in Forensic Science*, 61 VAND. L. REV. 199, 208-09 (2008) (discussing the lack of empirical validation for foundational theories in the forensic identification field).

the plaintiff's illness (referred to as "specific causation").[53] Again, whereas scientists work comfortably at the level of general causation, statements about individual cases are fraught with difficulty.[54]

Given the pragmatic nature of the rules of evidence, the solution to the division of authority between judge and jury is fairly straightforward. Because I've written at length on this subject, I will not relate the full analysis here. Suffice it to say that under Rule 702, if the empirical issue presented transcends the specific case at hand, it implicates the judge's gatekeeping responsibilities; case-specific factual determinations rest with the jury.[55] As my coauthors and I explained:

> It is a well-established aspect of our modern jury system that, while laypeople are in charge of finding facts specific to the case at hand, courts are the appropriate entity for ascertaining legal rules that will have application to other cases, a practice that is based in part on an assessment of the relative capacities of judges and juries and in part on a desire for uniformity across cases . . . . [T]he same rule should apply for facts that will have application to other cases, for the same reasons. A determination of whether scientific testimony is reliable should be the province of a legally trained individual cognizant of the difficulties of determining scientific validity and required to make a public ruling subject to appellate review, not hidden within an isolated verdict delivered by laypeople. Acceptance of that proposition means that the role of the judge and jury should depend not on a distinction between methodology and conclusion but on the distinction between the general and the specific. The reliability that *Daubert*, *Joiner*, and Rule 702 all require the judge to determine as a preliminary fact entails assessing every aspect of scientific evidence, not just its methodology or some other subset of the testimony.
>
> At the same time, the general-specific distinction that derives from the nature of scientific inference also means that, whether they involve methods or conclusions, factual disputes that relate solely to the case at hand are for the jury to assess. Thus, whether an expert in the instant case actually applied the methodology that the judge

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[53] Faigman et al., *supra* note 22, at 435.

[54] *See* Sanders, et al., *supra* note 24, at 854-55.

[55] The *Daubert* Court sought to describe the boundary between a judge's admissibility responsibilities and a jury's weight determination by holding that the former was limited to methodology and the latter to conclusions. *See* Daubert v. Merrell Dow Pharms., Inc., 509 U.S. 579, 594-95 (1993) ("The inquiry envisioned by Rule 702 is, we emphasize, a flexible one. Its overarching subject is the scientific validity and thus the evidentiary relevance and reliability—of the principles that underlie a proposed submission. The focus, of course, must be solely on principles and methodology, not on the conclusions that they generate."). *But see* General Electric Co. v. Joiner, 522 U.S. 136, 146 (1997) ("But conclusions and methodology are not entirely distinct from one another. Trained experts commonly extrapolate from existing data. But nothing in either *Daubert* or the Federal Rules of Evidence requires a district court to admit opinion evidence that is connected to existing data only by the *ipse dixit* of the expert.").

> found valid generally is a matter of weight, as is any conclusion the expert reaches that is applicable only to the litigants. The only caveat here is the traditional one that the judge may keep these issues from the jury when no rational jury could credit the expert's assertions about them.[56]

G2i raises an additional procedural concern, one that was the subject of *Joiner*, where the Court held that the abuse of discretion standard applies to trial courts' Rule 702 admissibility rulings.[57] This decision was largely premised on the belief that scientific evidence is like other kinds of evidence.[58] However, it is not.

Under Rule 702, a judge must find, by a preponderance of the evidence, that "the testimony is the product of reliable principles and methods."[59] Compare this preliminary fact to Rule 803(2)'s hearsay exception for an "excited utterance," which requires the judge to find, by a preponderance of the evidence, that the statement was in response to "a startling event or condition, made while the declarant was under the stress of excitement that it caused."[60] Findings of fact inherent in Rule 803 applications are case-specific and typically depend on assessments of witnesses appearing before the court. In contrast, by definition, the general findings of scientific research that must be assessed under Rule 702 transcend individual cases. Glyphosate's risk of causing cancer is the same in Brooklyn as it is in Manhattan. An appellate court deferring to a trial court's finding that a statement was made in "a startling event or condition" is reasonable, since the lower court is in a better position to assess the demeanor of the witness who testified to that fact. However, an appellate court has as much opportunity, and maybe more, to assess the toxicological and epidemiological research that is the basis for claims regarding the cancerous effects of Glyphosate. Moreover, given that the fact of the matter is the same in Brooklyn as it is in Manhattan, it would be fundamentally unfair for courts in the Eastern and Southern Districts to come to different conclusions on this scientific question. Hence, *Joiner's* abuse of discretion standard, which would allow such unsound outcomes, is fundamentally misconceived for empirical issues that transcend a particular case.

Daubert and the amendments to Rule 702 ushered in a new era, one in which judges must do more than simply count noses of members of some identifiable field of expertise to measure "general acceptance." Rule 702 requires judges to understand and evaluate the methods and principles of proffered scientific evidence.

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[56] David L. Faigman, Christopher Slobogin, & John Monahan, *Gatekeeping Science: Using the Structure of Scientific Research to Distinguish Between Admissibility and Weight in Expert Testimony*, 110 NW. L. REV. 859, 864-65 (2016).

[57] *Joiner*, 522 U.S. at 147.

[58] *See id*. at 141-42 (explaining that a district court's evidentiary rulings, including those on scientific expert testimony, are subject to the same abuse of discretion standard as other types of evidence).

[59] FED. R. EVID. 702(c); *Daubert*, 509 U.S. at 592 n.10 ("These matters should be established by a preponderance of proof.").

[60] FED. R. EVID. 803(2); *see* FED. R. EVID. 104(a); Bourjaily v. United States, 483 U.S. 171, 176 (1987).

As Chief Justice Rehnquist complained, this might indeed require judges to be "amateur scientists."[61] This obligation, however, extends beyond the procedural domain of evidence law, as the next sections consider.

2. Administrative Law

In administrative law, the role of ultimate fact-finder might be played by an assortment of actors, principally including legislatures, agencies, and courts. Although constitutional principles, such as separation of powers, provide guidance, like the Sixth and Seventh Amendments do in regard to juries, that guidance is not unambiguous. Such principles provide a starting point, but as the Court's jurisprudence illustrates, reasonable interpreters of the Constitution can disagree among these potential decision makers.

During oral argument in *Massachusetts v. EPA*, a case involving EPA's power to regulate greenhouse gases, Justice Scalia mistakenly referred to the stratosphere instead of the troposphere.[62] A lawyer for Massachusetts gently corrected him.[63] "Troposphere, whatever," Scalia responded. "I told you before I'm not a scientist. That's why I don't want to have to deal with global warming, to tell you the truth."[64] Yet in *Loper Bright Enterprises v. Raimondo*,[65] the Court jettisoned the doctrine of deference adopted in *Chevron v. NRDC*,[66] thus effectively calling upon judges to do exactly what Justice Scalia sought to avoid and for which he felt ill-equipped.

The *Loper Bright* Court argued that *Chevron* erred in moving the responsibility to decide legal questions from courts to agencies.[67] It surveyed the history of responsibilities for deciding matters of law, starting where all such discussions begin, with *Marbury v. Madison*.[68] There, Chief Justice Marshall famously declared that "[i]t is emphatically the province and duty of the judicial department to say what the law is."[69] According to the *Loper Bright* Court, this responsibility extended fully into the time when administrative processes expanded rapidly following the New Deal.[70] The Court contrasted the responsibility for deciding applicable law with agencies' responsibility for fact-finding. The Court stated as follows:

> During this period, the Court often treated agency determinations of fact as binding on the courts, provided that there was "evidence to support the findings." *St. Joseph Stock Yards Co.*

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[61] *Daubert*, 509 U.S. at 600-01 (Rehnquist, C.J., dissenting).

[62] Transcript of Oral Argument at 22, Massachusetts v. E.P.A., 549 U.S. 497 (2007) (No. 05-1120).

[63] *Id*.

[64] *Id*. at 23.

[65] Loper Bright Enters. v. Raimondo, 144 S. Ct. 2244 (2024).

[66] Chevron, U.S.A., Inc. v. Nat. Res. Def. Council, Inc., 467 U.S. 837 (1984).

[67] Loper Bright Enter., 144 S. Ct. at 2263-66.

[68] *Id*. at 2257.

[69] *Id*. at 2257 (quoting Marbury v. Madison, 5 U.S. (1 Cranch) 137, 177 (1803)).

[70] *Id*. at 2258.

> *v. United States*, 298 U.S. 38, 51, 56 S. Ct. 720, 80 L. Ed. 1033 (1936). "When the legislature itself acts within the broad field of legislative discretion," the Court reasoned, "its determinations are conclusive." *Ibid*. Congress could therefore "appoint[ ] an agent to act within that sphere of legislative authority" and "endow the agent with power to make *findings of fact* which are conclusive, provided the requirements of due process which are specially applicable to such an agency are met, as in according a fair hearing and acting upon evidence and not arbitrarily." *Ibid*. (emphasis added).[71]

The deference identified here is seemingly restricted to case-specific adjudicative facts. Such deference, however, is not necessarily owed to the many administrative judgments that are mixed questions of fact and law. *Loper Bright* cited scholarly commentary focusing on this complication, quoting Professor Bernard Schwartz's statement "that §706 [of the APA] 'would seem … to be merely a legislative restatement of the familiar review principle that questions of law are for the reviewing court, at the same time leaving to the courts the task of determining in each case what are questions of law."[72] Hence, the non-deferential standard adopted in *Loper Bright* places the burden on courts to resolve legislative facts integral to whatever question of law is implicated.

Among a score of critics of the majority opinion, Justice Kagan, joined by Justices Sotomayor and Jackson in dissent, voiced significant concerns with giving courts the responsibility of determining the scientific and technical facts that are intertwined with the law and policy embedded in a statute's text.[73] She observed: "Some interpretive issues arising in the regulatory context involve scientific or technical subject matter. Agencies have expertise in those areas; courts do not. Some demand a detailed understanding of complex and independent regulatory programs. Agencies know those programs inside-out; again, courts do not. And some present policy choices, including trade-offs between competing goods."[74]

Justice Kagan, who was an administrative law professor before she joined the Court, set forth a litany of examples that merit quoting at length. As she emphasized, theory only takes the issue so far, whereas concrete examples make plain "what a typical *Chevron* question looks like."[75] Such questions are regularly infused with complex scientific and technical matters. The following examples, all mixed questions of law and fact, illustrate the burden courts are assuming after *Loper Bright* to be scientifically literate:

- Under the Public Health Service Act, the Food and Drug Administration (FDA) regulates "biological product[s]," including "protein[s]." 42 U.S.C. § 262(i)(1). When does an alpha amino acid

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[71] *Id*. at 2258.

[72] *Id*. at 2262 (quoting Bernard Schwartz, *Mixed Questions of Law and Fact and the Administrative Procedure Act*, 19 FORD. L. REV. 73, 84-85 (1950)).

[73] *Id.* at 2294-96 (Kagan, J., dissenting).

[74] *Id*. at 2294.

[75] *Id*. at 2296.

polymer qualify as such a "protein"? Must it have a specific, defined sequence of amino acids? See *Teva Pharmaceuticals USA, Inc. v. FDA*, 514 F. Supp.3d 66, 79–80, 93–106 (D.C.C. 2020).

- Under the Endangered Species Act, the Fish and Wildlife Service must designate endangered "vertebrate fish or wildlife" species, including "distinct population segment[s]" of those species. 16 U.S.C. § 1532(16); see § 1533. What makes one population segment "distinct" from another? Must the Service treat the Washington State population of western gray squirrels as "distinct" because it is geographically separated from other western gray squirrels? Or can the Service take into account that the genetic makeup of the Washington population does not differ markedly from the rest? See *Northwest Ecosystem Alliance v. United States Fish and Wildlife Serv.*, 475 F.3d 1136, 1140–1145, 1149 (CA9 2007).
- Under the Medicare program, reimbursements to hospitals are adjusted to reflect "differences in hospital wage levels" across "geographic area[s]." 42 U.S.C. § 1395ww(d)(3)(E)(i). How should the Department of Health and Human Services measure a "geographic area"? By city? By county? By metropolitan area? See *Bellevue Hospital Center v. Leavitt*, 443 F.3d 163, 174–176 (CA2 2006).
- Congress directed the Department of the Interior and the Federal Aviation Administration to reduce noise from aircraft flying over Grand Canyon National Park—specifically, to "provide for substantial restoration of the natural quiet." § 3(b)(1), 101 Stat. 676; see § 3(b) (2). How much noise is consistent with "the natural quiet"? And how much of the park, for how many hours a day, must be that quiet for the "substantial restoration" requirement to be met? See *Grand Canyon Air Tour Coalition v. FAA*, 154 F.3d 455, 466–467, 474–475 (CADC 1998).
- Or take *Chevron* itself. In amendments to the Clean Air Act, Congress told States to require permits for modifying or constructing "stationary sources" of air pollution. 42 U.S.C. § 7502(c)(5). Does the term "stationary source[ ]" refer to each pollution-emitting piece of equipment within a plant? Or does it refer to the entire plant, and thus allow escape from the permitting requirement when increased emissions from one piece of equipment are offset by reductions from another? See 467 U.S. at 857, 859, 104 S. Ct. 2778.[76]

Justice Kagan summarized the essential point: "It is frequently in the consideration of mixed questions that the scope of statutory terms is established and their meaning defined."[77] By overturning *Chevron* deference and adopting a de

[76] *Id*. at 2296-97.

[77] *Id*. at 2306 (citing Henry Monaghan, *Marbury and the Administrative State*, 83 COLUM L. REV. 1, 29 (1983)).

novo standard of review for mixed questions of law and fact under the APA, the Court was effectively designating judges to be amateur scientists, much as it had under *Daubert*. As Justice Kagan observed, this was a responsibility that courts are ill-prepared to carry out.[78]

Although the *Loper Bright* Court did not engage extensively with this new reality, it expressly accepted the responsibilities this new rule established. The Court stated:

> But even when an ambiguity happens to implicate a technical matter, it does not follow that Congress has taken the power to authoritatively interpret the statute from the courts and given it to the agency. Congress expects courts to handle technical statutory questions.[79]

Justice Kagan, like Chief Justice Rehnquist in *Daubert* before her, complained that "[j]udges are not experts in the field."[80] With the death of *Chevron* deference, however, they are now expected to be.

3. Constitutional Law

Constitutional law presents a complicated picture regarding starting principles for allocating fact-finding authority. Here, the range of decision makers includes legislatures, agencies, judges, and juries. Moreover, the allocation often will depend on the respective provisions of the Constitution as well as the nature of the fact to be decided.[81] As discussed in greater detail below, some factual issues are relevant to crafting a constitutional rule, while others are relevant to an existing rule. Additionally, some facts that need to be determined under an existing rule are of general nature, so their determination should apply to all similar cases, while other facts are unique to individual cases. Therefore, the complexities here are great, and this section is meant only to introduce the subject, which I've considered at book-length elsewhere.[82]

In *Roper v. Simmons*,[83] Justice Kennedy, writing for the Court, held that imposing the death penalty on those who had committed their crimes when they were under eighteen years of age was unconstitutional under the Eighth

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[78] *Id*. at 2299.

[79] *Id*. at 2267. The Court pointed out that a judge's task is not to "decide such questions blindly." *Id*. They are aided in these responsibilities by the expertise of agencies, "among other information, at its disposal." *Id*. Presumably, this other information includes the parties' briefs, as well as possibly amicus briefs from interested third parties and even independent research conducted by the court.

[80] *Id*. at 2310.

[81] Kenneth L. Karst, *Legislative Facts in Constitutional Litigation*, 1960 SUP. CT. REV. 75, 75-77 (1960).

[82] *See* DAVID L. FAIGMAN, CONSTITUTIONAL FICTIONS: A UNIFIED THEORY OF CONSTITUTIONAL FACTS (2008).

[83] Roper v. Simmons, 543 U.S. 551, 578 (2005).

Amendment, thus overturning *Stanford v. Kentucky*.[84] The decision was largely based on the Court's review of surveys regarding evolving standards surrounding minors and the death penalty and the developing scientific literature indicating that children are different.[85] Children, compared to adults, have an underdeveloped sense of responsibility, are particularly susceptible to outside pressures, and lack fully formed characters.[86] However, a close review of that scientific literature reveals that these differences persist on average into a person's early twenties, while the Court drew the line categorically at eighteen.[87] Moreover, and often not noticed, the Missouri Supreme Court below had already effectively overturned *Stanford* on the basis that the predicate facts on which that decision rested had changed.[88] Although the Court never reached the issue, *Roper* presented the interesting question of whether lower courts can overturn higher court precedent when the predicate facts of that precedent have changed.[89]

Although Davis's dichotomy between legislative and adjudicative facts has been hugely influential, its application in constitutional cases is problematic. His division of facts into legislative and adjudicative depends on how the fact-finder employs the pertinent fact. If the fact is used to resolve a particular litigation, it is by definition "adjudicative." This is so even though the fact might transcend the particular dispute, such as whether Bendectin causes birth defects.[90] This approach, of course, led to the *Joiner* Court's view that scientific evidence proffered in an adjudication should receive deferential review on appeal even when the fact is of general import.

The incompleteness of Davis's administrative law distinction for constitutional cases led me to propose three classes of constitutional fact.[91] Davis's legislative

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[84] Stanford v. Kentucky, 492 U.S. 361 (1989).

[85] *See Roper*, 543 U.S. at 568-71.

[86] *See id*.

[87] *See id*. at 574 (noting that "[t]he qualities that distinguish juveniles from adults do not disappear when an individual turns 18").

[88] *See* State *ex rel.* Simmons v. Roper, 112 S.W.3d 397, 397 (Mo. 2003), *aff'd sub nom*. Roper v. Simmons, 543 U.S. 551 (2005) ("[E]xecution of individuals under 18 years of age at the time of their capital crimes is prohibited by the Eighth Amendment.").

[89] In *Roper*, the Court accepted certiorari on two questions presented for review. The second one asked the ultimate question regarding the constitutionality of the death penalty on a person who commits murder at age seventeen. Brief for Petitioner at i, Roper v. Simmons, 543 U.S. 551 (2005) (No. 03-633). The first question presented, which the Court never answered, asked: "Once this Court holds that a particular punishment is not 'cruel and unusual,' and thus not barred by the Eighth and Fourteenth Amendments, can a lower court reach a contrary decision based on its own analysis of evolving standards?" *Id*.

[90] This problem is present in the reverse direction as well. If a legislature identifies a case-specific fact to support its lawmaking, it becomes "legislative" by Davis's definition. *See* Davis, *supra* note 19, at 402. This occurred in the "right-to-die" controversy involving Terri Schiavo in 2005. *See generally* O. Carter Snead, *Dynamic Complementarity: Terri's Law and Separation of Powers Principles in the End-of-Life Context*, 57 FLA. L. REV. 53 (2005) (reviewing the enactment and eventual invalidation of Terri's Law, through which the Florida Legislature attempted to overturn judicial rulings in the highly publicized end-of-life case of Terri Schiavo).

[91] *See* FAIGMAN, CONSTITUTIONAL FICTIONS, *supra* note 82, at 46.

category can be divided into "constitutional doctrinal facts" and "constitutional reviewable facts." For the third category, I renamed the adjudicative category to "constitutional case-specific facts" to clarify that they correspond to the "i" of G2i, as opposed to the purely definitional character of Davis's adjudicative fact designation.

As I described elsewhere,

> *Constitutional doctrinal facts* are advanced to substantiate a particular interpretation of the Constitution. Doctrinal facts join, and sometimes are a component of, the traditional sources of authority—the text, original intent, constitutional structure, precedent, scholarship and contemporary values—in establishing the meaning of the Constitution… Doctrinal facts, therefore, are employed to determine or justify the development of rules or standards that apply to all similarly situated cases.[92]

Many doctrinal facts are historical, often debated as matters of original intent. The cornerstone of modern Second Amendment jurisprudence is premised on historical arguments regarding whether that provision was intended to be limited to its prefatory clause, "[a] well regulated militia."[93] But many factual assertions are embedded in explanations for the interpretations given to the archaic and ambiguous expressions of the Constitution. Chief Justice Marshall, for example, argued that legislators are less likely than judges to be bound by a written Constitution.[94] And Justice Brennan argued that failure to create a libel rule that did not allow for even false statements made about public figures to be protected by the First Amendment would chill speech.[95] The "actual malice" standard essentially codifies a doctrinal fact about human behavior. These sorts of behavioral assumptions are, or could be, subjects of empirical work of political scientists, sociologists, and social psychologists.

In contrast to doctrinal facts,

> *[c]onstitutional reviewable facts* embody the more generally recognized function of legislative fact-finding in constitutional cases. Courts examine reviewable facts under the pertinent constitutional rule or standard to determine the constitutionality of some state or federal action. Reviewable facts transcend particular disputes and thus can recur in identical form in different cases and varying jurisdictions.[96]

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[92] *Id.* at 46. As noted there, original intent is almost wholly a factual inquiry. And a cornerstone of judicial review is premised on the political science or sociology proposition that legislators are less likely than judges to be bound by a written constitution. *See* Marbury v. Madison, 5 U.S. 137, 178 (1803).

[93] *See* District of Columbia v. Heller, 554 U.S. 570, 610-619 (2008).

[94] *See Marbury*, 5 U.S. at 178.

[95] *See* New York Times Co. v. Sullivan, 376 U.S. 254, 279 (1964).

[96] FAIGMAN, CONSTITUTIONAL FICTIONS, *supra* note 82, at 47 (emphasis in original).

Constitutional cases are replete with reviewable facts. Does home consumption of wheat substantially affect commerce?[97] What are the mental and physical health consequences of gender-affirming care for minors?[98] What are the effects of social media on children's well-being?[99] It's difficult to find constitutional cases in which a basic liberty is implicated and the government or state's justification for any infringement does not involve constitutionally reviewable facts.

Finally, constitutional case-specific facts "refer to factual determinations that are relevant to the application of constitutional rules in particular cases."[100] Hence, for example, under the First Amendment, whether a defamatory statement was made with "actual malice,"[101] or whether particular speech is "directed at inciting or producing imminent lawless action" and is "likely to incite or produce such action,"[102] are case-specific facts.

The important question of what level of fact-finding is relevant in a particular constitutional domain is itself a matter of constitutional interpretation. The landmark case of *Brown v. Board of Education* illustrates this point.[103] In one of the most famous footnotes in constitutional history—and some would call it infamous—the *Brown* Court cited social science research conducted by Kenneth Clark indicating the negative effects of segregation on Black school children.[104]

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[97] *See* Wickard v. Filburn, 317 U.S. 111, 128-29 (1942). In *Gonzales v. Raich*, the Court considered whether home production of marijuana was within Congress's commerce power. 545 U.S. 1 (2005). The Court found that it has "a substantial effect on supply and demand in the national market for that commodity." *Id.* at 19. The Court explained:

> One need not have a degree in economics to understand why a nationwide exemption for the vast quantity of marijuana . . . locally cultivated for personal use (which presumably would include use by friends, neighbors, and family members) may have a substantial impact on the interstate market for this extraordinarily popular substance.

Id. at 28.

[98] *See* Williams *ex rel.* L. W. v. Skrmetti, 83 F.4th 460 (6th Cir.), *cert. dismissed in part sub nom*. Doe v. Kentucky, 144 S. Ct. 389 (2023), *and cert. granted sub nom*. United States v. Skrmetti, 144 S. Ct. 2679 (2024) (concerning whether Tennessee's law banning gender-affirming hormone therapies for transgender minors violates the Equal Protection Clause of the Fourteenth Amendment).

[99] *See generally* ANGELA CALVIN ET AL., COMMON SENSE MEDIA, TEENS, TRUST, AND TECHNOLOGY IN THE AGE OF AI: NAVIGATING TRUST IN ONLINE CONTENT (2025), https://www.commonsensemedia.org/sites/default/files/research/report/teens-trust-and-technology-in-the-age-of-ai_v2_web.pdf [https://perma.cc/9AQH-XG6K].

[100] FAIGMAN, CONSTITUTIONAL FICTIONS, *supra* note 82, at 48 (emphasis in original).

[101] *See, e.g.*, New York Times Co. v. Sullivan, 376 U.S. 254, 276 (1964) ("This Court's duty is not limited to the elaboration of constitutional principles; we must also in proper cases review the evidence to make certain that those principles have been constitutionally applied.").

[102] *See* Brandenburg v. Ohio, 395 U.S. 444, 447 (1969).

[103] This example is further developed in DAVID L. FAIGMAN, LABORATORY OF JUSTICE: THE SUPREME COURT'S 200-YEAR STRUGGLE TO INTEGRATE SCIENCE AND THE LAW 170-98 (2004).

[104] *See* Brown v. Bd. of Educ., 347 U.S. 483, 494 (1954) ("Whatever may have been the extent of psychological knowledge at the time of *Plessy v. Ferguson*, this finding is amply supported by modern authority.") (citing, among other authorities, K. B. CLARK, EFFECT OF PREJUDICE AND

These were the infamous doll studies. But what level of fact-finding was necessary under the Equal Protection Clause for the appellants to prevail? The original research conducted by Clark in 1948 was general ("G") and was advanced to demonstrate the deleterious consequences of segregation. However, in the case itself, Clark conducted his doll tests in every locale that was involved in the litigation.[105] This was intended to show the consequences in the specific cases before the Court.[106]

At oral argument, the NAACP's Robert Carter tripped over this very issue. He argued that the district judge's findings of fact made reversal "necessary."[107] He argued, "If there [are inequalities] in fact, that educational opportunities cannot be equal in law."[108] Justice Hugo Black asked whether that was "a general finding or do you state that for the State of Kansas, City of Topeka?"[109] Apparently believing the relevant query was case-specific, Carter said, "the finding refers to the State of Kansas and to these appellants and to Topeka, Kansas."[110] He then added unhelpfully, "I think that the findings were made in this specific case referring to this specific case."[111] Black was troubled, however, by the implications of Carter's answer. Black pointed out, "then you would have different rulings with respect to the places to which this applies, is that true?"[112] Carter responded by falling back on the law, effectively abandoning the general fact that was the point of Clark's original research. He stated, "Now, of course, under our theory, you do not have to reach the finding of fact or a fact at all in reaching the decision because of the fact that we maintain that this is an unconstitutional classification being based upon race and, therefore, it is arbitrary."[113]

The *Brown* Court, of course, treated the effects of segregation as general facts, but were these facts doctrinal or reviewable? This turns out to be more complicated than it might first appear. Initially, following *Brown*, the Court invalidated segregation in multiple other contexts,[114] thus suggesting that the factual proposition was doctrinal in scope and supported a categorical rule against segregation or race-based state action. However, in the following decades, the

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DISCRIMINATION ON PERSONALITY DEVELOPMENT (Midcentury White House Conference on Children and Youth, 1950)).

[105] *See* FAIGMAN, *supra* note 103, at 176-90.

[106] Although this could be considered an issue of "i," Clark's work in each jurisdiction was still general in that he did not limit his inquiry to the specific named plaintiffs.

[107] REMOVING A BADGE OF SLAVERY: THE RECORD OF BROWN V. BOARD OF EDUCATION 131 (Mark Whitman ed., 1993) (quoted in FAIGMAN, LABORATORY OF JUSTICE, *supra* note 102, at 190).

[108] *Id.*

[109] *Id.*

[110] *Id.*

[111] *Id.*

[112] *Id.* at 132; *see also* Stell v. Bd. of Pub. Ed., 387 F.2d 486, 490-91 (5th Cir. 1967) (considering *Brown* to be case-specific).

[113] REMOVING A BADGE OF SLAVERY: THE RECORD OF BROWN V. BOARD OF EDUCATION, *supra* note 107, at 132.

[114] *See* Kevin H. Smith, *The Jurisprudential Impact of Brown v. Board of Education*, 81 N.D. L. REV. 115, 117 (2005).

Court considered the effects of race-based decision making, particularly in the context of affirmative action, as reviewable facts. In several high-profile cases, the Court applied strict scrutiny to the effects of race-based actions, thus making these sorts of facts reviewable rather than doctrinal.[115] Yet, more recently, the Court has largely retreated to viewing race-based state action categorically, and thus largely ruling that the empirical benefits or detriments of such action is not legally relevant at all.[116]

III. TOWARD A NUMERATE JUDICIARY

In 1993, the *Daubert* Court interpreted Rule 702 to empower judges to be "gatekeepers" to ensure that "junky science" did not reach jurors. Thirty years later, in 2023, Rule 702 was amended for the second time, since courts had largely failed to fulfill the responsibilities of that role.[117] In 1984, the *Chevron* Court held that courts owe deference to administrative agency interpretations of their rule-making authority, a task integrally tied to scientific and technical determinations made by agencies. In 2024, the *Loper Bright* Court overturned *Chevron* deference and thereby assumed an expanded role for the judiciary over scientific and technical questions.[118] In constitutional cases, the Court assumes responsibility for resolvinga wide range of empirical questions, from the developmental capacities of children[119] and individuals with intellectual disabilities[120] under the Eighth Amendment to the effects of race-based and gender-based decision making under the Equal Protection Clause of the Fourteenth Amendment.[121] In these three doctrinal areas, and across the entire jurisprudential spectrum, an essential part of judges' responsibilities is to decide scientific and technical issues. Yet, this is a skill that judges are neither trained to do nor have demonstrated a capacity for doing. This section crafts a solution to this deficit. In particular, it is a solution that can operate squarely within the adversarial process, which is the cornerstone of American adjudication, and that employs a process with time-tested ancient roots.[122]

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[115] *See, e.g.*, Grutter v. Bollinger, 539 U.S. 306, 328-29 (2003) ("[T]he Equal Protection Clause does not prohibit the Law School's narrowly tailored use of race in admissions decisions to further a compelling interest in obtaining the educational benefits that flow from a diverse student body.").

[116] *See* Angelo N. Ancheta, *Science and Constitutional Fact Finding in Equal Protection Analysis*, 69 Ohio St. L.J. 1115, 1116 (2008) (observing that in recent case law, "there are profound divisions over whether *Brown v. Board of Education* stands for a strict anti-classification norm of color-blindness or for an anti-subordination ideal that permits color-consciousness to address persistent racial inequality").

[117] *See* discussion *supra* Section II.B.1 and notes 36-61.

[118] *See* discussion *supra* Section II.B.2 and notes 62-80.

[119] *See* Monahan & Walker, *supra* note 18, at 509 (discussing New York v. Ferber, 458 U.S. 747 (1982)); *see also* Roper v. Simmons, 543 U.S. 551 (2005).

[120] *See* Atkins v. Virginia, 536 U.S. 304 (2002).

[121] *See* United States v. Virginia, 518 U.S. 515 (1996).

[122] Parts of this section are based on Faigman, *supra* note 12.

A. Gatekeeping Between Adversaries

The American adversarial system seems uniquely designed to obscure or marginalize moderate or consensus scientific opinion On most subjects of applied science that appear in court, scientific opinion varies but likely takes the shape of the well-known bell-shaped curve. Most scientists will group in the middle, and there will inevitably be some that feel strongly in favor of, and some who feel strongly against, the scientific proposition of interest. These scientists occupy the two tails of the distribution of scientific opinion.

Lawyers have no incentive to identify the central tendency of scientific opinion on any relevant subject. All applied science is probabilistic and infused with uncertainty. This uncertainty creates doubt, not something that litigants want to publicize. Indeed, the litigation process begins, and ends, with processes and practices that are likely to lead to expert polarization. Two such processes promote this outcome. First, litigators search for testifying experts that agree with their litigating position. Second, once the testifying expert is on-board, well, he or she is on-board.

That litigators seek experts who already agree, or are likely to agree, with their litigating position is hardly surprising. The adversarial system essentially requires it. The actual distribution of views in the field might, in fact, be quite narrow, largely clumping around a central consensus. Nonetheless, the incentives of the system demand that lawyers seek out outspoken experts that will situate their claims or defenses in the best empirical light possible.

Lawyers mine for experts that will testify in support of their claims.[123] These experts are likely to be selected from the opposite poles of the distribution of scientific opinion. The natural polarizing effect of the adversarial process means that courts often encounter experts who agree on little about the science. This disagreement might, in fact, reflect genuine disputes in the field, or it might be an artifact of the selection bias that went into identifying the experts in the first place. The well-worn cliché of the battle of the experts has much truth behind it. Judges are thus often confronted with polarized views of the field and no knowledge of, and little ability to find out, what is the middle ground view of the profession.

Another factor that likely contributes to the polarizing effects of the adversarial process is that experts become part of a legal team fighting to win the case.[124] Experts experience strong pressures to become team players. This might manifest in several ways, all contributing to this polarizing effect. First, it might lead experts to state their opinions more forcefully than they otherwise would on a controversial issue. Second, experts might be persuaded to state their conclusions categorically, rather than probabilistically. Third, the team atmosphere might buttress experts' confidence in their opinions and allay any reasonable doubts about their position. Finally, party experts are more likely to use legal verbiage to describe their opinions, thus translating the science for courtroom consumption and leaving certain key assumptions unstated.

From the judge's perspective, dueling experts are the rule, not the exception. The judge has little opportunity to assess the median scientific opinion in a field, much less to determine whether one or the other party's expert represents that mainstream view. To be sure, a party's expert will do his or her best to educate the judge regarding the defects in the opponent's expert's position. And vice versa for the other party. But without a depth of knowledge in the field, the judge's task is a challenging one. Of course, courts have the option of hiring court-appointed experts under most evidence codes, or even technical advisers or special masters, to assist them. However, the option of bringing in appointed help is rarely exercised.[125] It is perceived as both too expensive and prone to usurp the adversarial process.[126]

B. An Innovative, But Venerable, Solution: Peer Review

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[123] *See* Jonah B. Gelbach, *Expert Mining and Required Disclosure*, 81 U. CHI. L. REV. 131, 131-32 (2014).

[124] *See* Daniel C. Murrie & Marcus T. Boccaccini, *Adversarial Allegiance among Expert Witnesses*, 11 ANN. REV. L. & SOC. SCI. 37, 46 (2015) (finding strong empirical evidence for adversarial allegiance among expert witnesses, even regarding ostensibly objective matters).

[125] *See* Cecil & Willging, *supra* note 14, at 1004-08.

[126] *Id*. at 1018-19 (discussing judge's respect for the adversarial system), 1045-46 (discussing issues with compensating court-appointed experts).

Both *Daubert* and *Frye*[127] capture the basic idea correctly. Courts cannot employ science responsibly if they do not understand its basic content, and there is much value in asking those who know. But, as currently framed, courts are incapable of using either test effectively. The solution to this riddle is an ancient one, and one that is integral to all scientific fields and, indeed, virtually all academic disciplines: Courts should refer expert reports out for peer review.

The core insight of bringing peer review to expert testimony belongs to Judge Jack Weinstein.[128] Judge Weinstein was not generally known as a judge that regularly excluded expert testimony. But his scientific sensibilities were sound, and he sometimes had to do just that. In an *Oregon Law Review* article, he explained one such occasion as follows:

> Several years ago, I tried a case involving whole-cell pertussis vaccine. The plaintiff was an infant of four or five months with a history of seizures, who was given a whole cell pertussis vaccination. Her brain, it was later discovered, was profoundly damaged. The cause of her neurological disorder was unclear. The questions posed at trial were whether it was improper to administer the vaccine in view of the seizures and whether the vaccine caused the seizures.
>
> In opposition to the defendant's fully credentialed experts, the plaintiff called a scientist I would consider borderline, under *Daubert*, in terms of expert credentials. He had the proper degrees and had done some research, but he had published nothing on the subject and had entered the field at the request of plaintiff's attorney. He relied wholly upon secondary sources—a large number of published articles—to prepare himself for cross-examination.
>
> The jury found, nevertheless, for the plaintiff. As a profoundly disabled child, her case was, obviously, very compelling. At that point, I set aside the verdict, taking into account all of the evidence, including the inadequacy, in my view, of the proof presented by the plaintiff's expert.[129]

Judge Weinstein speculated about what courts might do to ensure that experts bring better quality science to the courtroom. Among several possibilities, Judge Weinstein suggested bringing experts' courtroom testimony to the greater attention of their respective professional communities.[130] Such a course would bring a sort

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[127] Frye v. United States, 293 F. 1013, 1014 (D.C. Cir. 1923) (establishing the Frye Standard for admission of expert testimony, which requires that the scientific principle upon which the testimony is based "must be sufficiently established to have gained general acceptance in the particular field in which it belongs").

[128] I first explored some of the issues discussed in this section, along with my coauthor Claire Lesikar, in David L. Faigman & Claire Lesikar, *Organized Common Sense: Some Lessons from Judge Jack Weinstein's Uncommonly Sensible Approach to Expert Evidence*, 64 DEPAUL L. REV. 421, 429-33 (2015).

[129] Jack B. Weinstein, *Science and the Challenges of Expert Testimony in the Courtroom*, 77 OR. L. REV. 1005, 1009 (1998).

[130] *Id.* at 1009-10.

of professional peer review to expert testimony. He believed that "the publication of expert testimony, or synopses of such testimony, in professional journals" might bring a needed mainstream scientific perspective to bear in the courtroom.[131] Judge Weinstein explained:

> We have often touted the advantages of our system of public trials, in which witnesses appear in open court. As a practical matter, however, there are rarely more than a few spectators in the courtroom. Most scientists do not have time to become legal buffs, hanging out at the local courthouse waiting for trials involving scientific evidence to unfold. Publication would be a means of bringing expert testimony to the attention of those who are in a position to evaluate it.[132]

This suggestion anticipates Justice Breyer's often quoted statement in *Kumho Tire Co. v. Carmichael*, in which he explained that a primary purpose of the "*Daubert* gatekeeping requirement . . . is to make certain that an expert, whether basing testimony upon professional studies or personal experience, employs in the courtroom the same level of intellectual rigor that characterizes the practice of an expert in the relevant field."[133] Judge Weinstein's publication idea provides a concrete way to achieve Justice Breyer's point

Frye and *Daubert* both contemplate that the law should employ scientific knowledge that has achieved some credibility in the field from which it comes. Neither, however, details how this should be accomplished as a practical matter. *Frye* calls upon courts to assess the level of acceptance of the basis for proffered scientific testimony,[134] but courts have no ready mechanism to survey applicable fields. *Daubert* calls upon judges to adjudge the validity of the basis for proffered scientific testimony by considering the scientific merits themselves or proxies of the merits such as general acceptance,[135] though courts have demonstrated little ability to carry out this function. The question then is, given demands that courts bring scientific sensibilities to the issues of admissibility, statutory interpretation, and constitutional law, how can courts best obtain and utilize those sensibilities. Peer review is a promising alternative.

1. The Foundations of Peer Review

Although the contemporary process of systematic blind peer review is of relatively recent vintage, the concept of subjecting scientific claims to the evaluation of peers is ancient. Indeed, an early documented example comes from the book "Ethics of the Physician," by Ishap bin Ali Al Rahwi, who lived around

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[131] *Id.* at 1011.

[132] *Id.* at 1011-12.

[133] Kumho Tire Co. v. Carmichael, 526 U.S. 137, 152 (1999).

[134] Frye v. United States, 293 F. 1013, 1014 (D.C. Cir. 1923).

[135] Daubert v. Merrell Dow Pharms., Inc., 509 U.S. 579, 594-95 (1993).

900 AD.[136] This book advised that it was the duty of the physician to take detailed notes of his treatment and have those notes reviewed by a local council of physicians.[137] Based on these notes and the corresponding reviews, a physician could be held liable for maltreatment.[138]

More formal and systematic efforts of peer review had to await Gutenberg's invention of the printing press. The event identified as the inception of the modern approach to peer review occurred around 1752, when the Royal Society of London assumed control of the journal *Philosophical Transactions*.[139] It adopted an approach used by the Royal Society of Edinburgh dating to 1731, which relied on a select group of members knowledgeable in the respective field to evaluate submissions.[140] These reviews were relied on by the editors in making publication decisions. The process of peer review deepened and expanded over time and became the standard approach for selecting manuscripts for publication in the 20th century.[141] Although the internet has expanded the ways peer review might occur, including crowd-sourcing, blogs, and other innovations, the basic model of subjecting scientific claims to the review of those most knowledgeable in the respective field is deeply entrenched in contemporary scientific practice.[142]

Granted, peer review, as many have pointed out, suffers from limitations.[143] It is inherently conservative, tends to reinforce dominant views in the field, and may be unavailable or unduly restrictive for certain fields of study.[144] But from the law's perspective, some of these limitations are virtues. The law is a conservative enterprise. In the domain of scientific evidence, courts are ill-suited to identify emerging trends or to distinguish between those promising hypotheses that will eventually gain acceptance and those destined for the junk heap. To be sure, a conservative approach risks that the law will not recognize the next Einstein that

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[136] *See* Ray Spier, *The History of the Peer-Review Process*, 8 TRENDS BIOTECH. 357, 357 (2002) (citing M.Z. Kawi, *History of Medical Records and Peer Review*, 17 ANNALS SAUDI MED. 277, 277 (1977)).

[137] *Id.*

[138] *Id.*

[139] *Id.*

[140] *Id.* at 357-58.

[141] *Id.*

[142] *Id.* at 358.

[143] *See, e.g.*, Adrian Mulligan, *Is Peer Review in Crisis?* 41 ORAL ONCOLOGY 135, 135-36 (2004); Chris Harrison, *Peer Review, Politics and Pluralism*, 7 ENV'T SCI. & POL'Y 357, 360-61 (2004).

[144] *See* Harrison, *supra* note 143, at 360.

comes along; but it also would avoid the next Lysenko,[145] or the myriad of junky claims that have appeared on the witness stand in the guise of forensic science.[146]

Peer review provides an invaluable check on scientific claims. In fact, it is the centerpiece of the scientific community, and one that, while competing to uncover new truths, cooperates in the general enterprise of advancing knowledge. If done well, which usually involves some level of anonymous—i.e., "blind"—evaluation,[147] the law could be provided with objective and detached evaluations of the methods and principles that underlie scientific opinion testimony. This would produce a host of salutary benefits. First, it would give courts a window into the mainstream views of the respective scientific field, ala *Frye*. *Frye* provided no mechanism for assessing general acceptance in a field, other than querying the self-interested party expert on the subject or surveying other courts. Independent peer review provides such a mechanism. Second, the reports of peer reviewers would provide a detailed written explanation and evaluation of the bases for the expert opinion. Although the parties' expert reports do this as well—at least in civil litigation[148]—independent peer reviewers are likely to give a more detached, discipline-level view of the issues. Finally, over time, if peer review becomes an accepted—or even expected—aspect of threshold admissibility decisions, the party experts themselves will likely better tailor their own opinions to those of the mainstream. This will mean that disagreements to be resolved in court reflect real debates in the field, rather than being the products of the litigants' choosing outlier experts.

A possible objection to the idea of bringing peer review to scientific evidence is one considered above: the American commitment to the adversarial process. After all, if judges are reluctant to hire court appointed experts, largely out of fidelity to the adversarial process, wouldn't they be reluctant to send out expert reports for peer review for the same reason? They might, but there are good reasons to think not. When used by judges, peer review is substantially less threatening to the adversarial process than court-appointed experts or technical advisers. Peer reviewers would not testify (unless separately invited to do so). Peer reviewers would not replace party experts. They would merely provide written reviews of one or more party experts, to which all of the interested parties would have a full opportunity to respond. They would also be significantly less expensive than court-appointed experts or technical advisers.

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[145] *See generally* E.W. Caspari & R.E. Marshak, *The Rise and Fall of Lysenko*, 149 SCIENCE 274-75 (1965) (discussing the factors, including prioritization of ideological alignment over empirical validation, that facilitated the rise of pseudoscientific theories by Soviet agronomist Tromfin Lysenko).

[146] *See generally* Michael J. Saks & David L. Faigman, *Failed Forensics: How Forensic Science Lost Its Way and How It Might Yet Find It*, 4 ANN. REV. L. & SOC. SCI. 149 (2008) (discussing the development of forensic fields lacking scientific validation and the role of courts in sustaining their underdeveloped state).

[147] *See* Mulligan, *supra* note 143, at 139.

[148] *See* FED. R. CIV. P. 26(a)(2)(B).

2. Bringing Peer Reviewers to Court

Most scientists ply their trade day-to-day quite happily with little or no concern for what occurs in courts. Indeed, most working scientists would prefer to avoid becoming embroiled in litigation as expert witnesses.[149] It can be an unpleasant experience. Enduring one or two cross-examinations is usually enough to last a lifetime. So why should scientists even consider lending their expertise to the endeavor suggested here–that is, providing detailed peer review of party experts' reports? There are several compelling reasons why scientists might wish to do so.

First, the law uses science daily in the administration of justice, with or without mainstream scientists' participation. In fact, recent history is replete with instances in which the courts have permitted—and indeed continue to permit—bad science. This has led to manifest unjust results, on both the civil and criminal sides of courts' dockets. On the civil side, for example, courts allowed the silicone implant cases to continue long after scientists denounced the empirical bases for them.[150] On the criminal side, the examples are so numerous that it led Dr. Donald Kennedy, then-editor of *Science*, to ask whether "forensic science" is an "oxymoron."[151] In his view, the so-called identification sciences of handwriting, non-DNA hair, toolmarks, bitemarks, and even fingerprinting, were sources of professional embarrassment.[152] Occasionally, outside groups, notably including the National Academies of Science, issue reports on the state of understanding of some area of concern for the law.[153] While profoundly important, these one-off peer reviews are not enough. Scientists, through a systematic and collective effort, have the opportunity to contribute to the fair and accurate use of science in the administration of justice.

A second reason to participate in the proposed peer review of expert testimony is that it does not entail getting embroiled in litigation, as serving as an expert witness oftendoes. The reviews themselves are essentially canned exercises involving the evaluation of a single expert report and the authority cited therein. The reviewers would be blind to the identity of the author of the report. There is no expectation that reviewers would testify in court, much less before a jury.

Finally, and not to be entirely discounted, reviewers would be paid for their work. Currently, of course, scientists participate in the peer review process without compensation, as part of their professional contributions and obligations to the

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[149] *See* Paul D. Carrington & Traci L. Jones, *Reluctant Experts*, LAW & CONTEMP. PROBS., Summer 1996, at 51, 59 (discussing potential concerns that experts may have with testifying in litigation).

[150] *See* MARCIA ANGELL, SCIENCE ON TRIAL: THE CLASH OF MEDICAL EVIDENCE AND THE LAW IN THE BREAST IMPLANT CASE 20-30 (1997).

[151] Donald Kennedy, *Forensic Science: Oxymoron?*, 302 SCIENCE 1625 (2003).

[152] *Id.*

[153] *See, e.g.*, NATIONAL RESEARCH COUNCIL, STRENGTHENING FORENSIC SCIENCE IN THE UNITED STATES: A PATH FORWARD (2009); *see also* PRESIDENT'S COUNCIL OF ADVISORS ON SCIENCE AND TECHNOLOGY, REPORT TO THE PRESIDENT, FORENSIC SCIENCE IN CRIMINAL COURTS: ENSURING SCIENTIFIC VALIDITY OF FEATURE-COMPARISON METHODS (2016).

profession at large.[154] Scientists generally owe no such fidelity to the law, though their participation is likely to have salutary effects there. Since there are considerable financial interests at stake in court, especially involving civil litigation, remuneration for the hours devoted by scientists to improve the law's use of science is both available and appropriate.

3. Defining a Peer Review Initiative

Courts are hardly in a position to employ peer review without considerable assistance. Indeed, such an effort would require the participation of an independent organization that would run the day-to-day operations. For judges, such an operation would likely need to be non-profit, and ideally associated with an influential scientific or professional organization, such as the National Academies of Science[155] or the Royal Society in the United Kingdom.[156] It might also be associated with one or more prestigious scientific publications, such as *Science*[157] or *Nature*,[158] which are already in the business of peer review.

The full logistical details of such an operation are beyond the scope of the present article. However, some basic principles that might form the foundation of such an initiative can be outlined. These include:

- *The subject matter of the peer review would be the written report(s) of the parties' experts*.

Modern civil discovery rules result in a detailed analysis of the relevant literature or experiential grounds supporting proffered expert opinion.[159] In many cases, these expert reports closely resemble manuscripts that are the bread and butter of peer review.

Detailed expert reports are likely to be available in many cases arising in administrative and constitutional law. Hence, the peer review process would operate similarly in those contexts as well. The area in which the above description is less effective is in criminal cases, some of which also present constitutional issues. Oddly, most jurisdictions do not require the sort of detailed expert reports that are

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[154] *See* Balazs Aczel et al., *A Billion-dollar Donation: Estimating the Cost of Researchers' Time Spent on Peer Review*, RSCH. INTEGRITY & PEER REV., Nov. 14, 2021, at 1, 1-2 (noting that most peer reviewers are not compensated and estimating that reviewers in the U.S. alone contribute approximately $1.5 billion worth of unpaid labor to peer review).

[155] THE NATIONAL ACADEMIES OF SCIENCES, ENGINEERING, AND MEDICINE, https://www.nationalacademies.org/home [https://perma.cc/P9P3-2L56] (last visited Feb. 27, 2025).

[156] THE ROYAL SOCIETY, https://royalsociety.org [https://perma.cc/FP5R-VDTK] (last visited Feb. 27, 2025).

[157] SCIENCE, https://www.science.org/ (last visited Feb. 27, 2025).

[158] NATURE, https://www.nature.com/ [https://perma.cc/ST4U-3NCE] (last visited Feb. 27, 2025).

[159] *See* FED. R. CIV. P. 26(a)(2)(A)-(B).

the mainstay of civil cases.[160] Although reports are available regarding, for instance, forensic examinations in areas such as DNA, fingerprints, and firearms and toolmarks, those reports generally provide no analysis whatsoever regarding the foundational validity of the relevant field, and only conclusory statements about the identifications made.[161] For example, in the area of firearms identification (a subfield of toolmarks identification), expert reports do not routinely include, if ever, the scientific literature pertaining to their field.[162] They simply offer conclusory statements that the bullets or cartridge cases in question "match." Indeed, they ordinarily do not even indicate what marks were identified as supporting their conclusion.[163]

- *Peer reviewers should be experts in the respective fields in which they are invited to review, but not necessarily on the narrow question presented in the report*.

A perennial problem with the application of the *Frye* standard in the evidence context is that courts would simply survey the narrow field from which the expert opinion was drawn. Asking epidemiologists who work exclusively on the substance in question whether the literature in which they have dedicated their careers is not likely to produce a neutral answer. Similarly, asking fingerprint experts whether fingerprint identification is valid will not provide an informed opinion. We might as well ask tea-leaf readers about the validity of tea-leaf reading. Although there are likely to be challenges in some fields, or in some cases—especially ones that are politically controversial, such as abortion—reviewers should be readily available for most of the sorts of questions courts confront.

- *Peer reviewers should be subject to a conflicts check and avoid any appearance of impropriety*.

Conflict of interest checks are a routine part of peer review, as well as participation on panels or committees making findings or recommendations. For example, the National Academies asks members of its committees that make findings, conclusions, and recommendations to complete a seven-page form

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[160] *See, e.g.*, FED. R. CRIM. P. 16(a)(1)(G); Paul W. Grimm, *Challenges Facing Judges Regarding Expert Evidence in Criminal Cases*, 86 FORDHAM L. REV. 1601, 1608-09 (contrasting the robust language in the Fed. R. Civ. P. 26(a)(2)(A)-(B) against the insufficiently detailed disclosure rules under the Fed. R. Crim. P. 16(a)(1)(G)).

[161] *See* PRESIDENT'S COUNCIL OF ADVISORS ON SCIENCE AND TECHNOLOGY, *supra* note 153, at 54 (noting troubling trend among expert witnesses to exaggerate the foundational validity of forensic sciences).

[162] *See, e.g.*, United States v. Taylor, 704 F. Supp. 2d 1192 (D.N.M. 2009) (excluding a firearms expert based on her unreliable treatment of the literature in the field); *see also* PRESIDENT'S COUNCIL OF ADVISORS ON SCIENCE AND TECHNOLOGY, *supra* note 153, at 113 (noting a lack of studies showing the validity of firearms analysis).

[163] *See* Alfred A. Biasotti, John E. Murdock, Bruce R. Moran & Eric Collins, Chapter 34, Sec. 34:15 Scientific Issues, *in* DAVID L. FAIGMAN, ET AL., MODERN SCIENTIFIC EVIDENCE: THE LAW AND SCIENCE OF EXPERT TESTIMONY, at 946, n.1 (describing a quantitative measure of marks that has yet to be adopted by the field, and citing authorities)

exploring conflicts ranging from financial to professional.[164] Similar checks should be employed in any peer review system.

- *Peer reviewers would be selected based on their research and reputation in the field, and their participation could be subject to timely objections by the parties*.

Given the underlying framework of the adversarial system, it would be prudent to give the parties adequate opportunity to object to the selection of a particular peer reviewer. The party would be expected to give reasons for its objection, and the court would assess the sufficiency of any objection.

- *Peer reviewers would limit their analyses to research and findings that transcend the case (i.e., to the "G", rather than the "i", of G2i*).

Peer review would be limited to the methods, principles, and reasoning underlying the opinions that transcend the individual case. For example, consider a plaintiff's expert reports offered in a typical toxic tort case. Toxicologists and epidemiologists might provide reviews of the relevant literature supporting the conclusion that a general causal relationship—"general causation"—exists between the substance in question and the plaintiff's illness. In addition, if general causation is supported by the literature, a clinician might submit a report offering an opinion on "specific causation," that is, that the substance more likely than not caused the plaintiff's illness. This latter opinion involves both general considerations and an application to the specific case. Specifically, the methodology used to make an inference from general causation to a specific case is known as "differential etiology."[165] The question of whether the method of differential etiology generally, and whether it was correctly applied in the case, are general questions and amenable to peer review. However, differential etiology queries what other factors might have caused the illness in question and thus whether those factors might be the cause of the illness. The case-specific aspects of this assessment would not be subject to peer review since the reviewer would not have access to, for instance, the plaintiff's medical history. Hence, whether cigarette smoking might be an alternative cause of the illness, and how that fact might be analyzed in relation to the putative cause, are subjects of peer review. Whether the plaintiff was a smoker, or how many packs a day he or she smoked, are case-specific questions. The peer reviewer would accept case-specific facts as set forth in the expert's report as true for purposes of her review.

- *Peer reviewers should be paid for their time, with compensation through the court, either out of funds paid by the parties (in civil cases) or public sources (in criminal cases*).

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[164] *Conflict of Interest and Disclosure Form for Committees Used in the Development of Findings, Conclusions, and Recommendations*, NAT. ACADS OF SCI., ENG'G & MED., https://www.nationalacademies.org/about/institutional-policies-and-procedures/conflict-of-interest-policies-and-procedures [https://perma.cc/3469-6RNE] (last visited Feb. 27, 2025).

[165] *See* Sanders, et al., *supra* note 24, at 853-54.

Most scientists participate in peer review pro bono.[166] It is considered part of their professional obligation to their field. Although utilizing peer review to assist judges in their responsibility to understand scientific evidence largely parallels the system employed by most scientific journals, the incentives are very different. A scientist might participate in peer review for a journal because the system depends on broad participation by the scientific community to succeed. A scientist completing a peer review for a court is doing a public service, but one that could be readily declined. Hence, in order to ensure broad participation in any peer review system, reviewers should receive sufficient compensation. The hourly rate for such work, however, would be well below what experts might expect when they agree to be party experts. The work is comparatively simpler, more straightforward, and not subject to cross-examination.

IV. CONCLUSION

The United States Supreme Court has increasingly adopted doctrines that place considerable gatekeeping responsibility for deciding factual scientific propositions on judges. This trend is well manifested in the areas of evidence, administrative, and constitutional law. Yet, on the whole, judges are not well-versed in the methods of science or the mathematical skills necessary to carry out this task. This Article suggests that the courts' gatekeeping responsibilities would be substantially improved by borrowing a venerable, albeit imperfect, institution from science: peer review.

Peer review is an eminently practical solution to what, to date, has been an intractable problem for the law. In all civil litigation, and potentially in criminal prosecutions as well, testifying experts provide detailed reports to support their proposed testimony. These reports are often the subject of intense discovery and depositions, and they provide the fodder for many preliminary hearings. Within this process, there is adequate time, opportunity, and need for scientific peer review. Scientists and other scholars have employed this method for millennia and it is today the standard practice for virtually all mainstream scholarly journals. In focusing courts' attention on the methodologies of science, *Daubert* should be understood as inviting courts to consider employing all of the instruments of modern science. Meanwhile, *Frye* calls upon judges to look to relevant fields of science to gauge the soundness of science offered in court. Peer review is responsive to both tests. It provides a window into mainstream science. Through that window, courts can see the bases for expert evidence and assess its level of acceptance within the scientific community. Peer review is thus an age-old solution to the perennial problem of how to bring scientific sensibilities into the courtroom.

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[166] *See* Aczel et al., *supra* note 154, at 1-2.