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EXPERTISE ON TRIAL[†]

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The problem of epistemic competence—the inability of courts to effectively interpret and apply scientific expert testimony to the resolution of legal disputes—has been a vexing one for nearly as long as expert witnesses have been routine fixtures in litigation. This Article argues that the intractability of the problem is the result of the epistemological paradigm by which the discussion has been framed. The existing literature makes an impossible demand: that individual legal decision makers possess substantive expertise in all scientific domains in which expert witnesses testify. Because judges and jurors are not omniscient, this demand can never be satisfied, and reform proposals have therefore been limited to mitigating the problem rather than solving it.

This Article proposes a new solution to the problem of epistemic competence. First, it traces the converging accounts of classical epistemology and the sociology of scientific knowledge to show that warranted judgments in matters of scientific fact can be made only by judges who possess expertise in the

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relevant scientific domain. Second, the Article draws on insights from social epistemology to advocate a collectivist epistemological paradigm wherein the institution of the court, rather than the individual judge and jurors, is the epistemic agent of interest. The Article describes a system of distributed cognition that would vest scientific expertise and legal authority in courts as institutional epistemic agents, thus solving the problem of epistemic competence. Finally, the Article describes one method by which the social epistemological solution might be implemented, by creating a new office of scientific experts within the federal judiciary.

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How long we shall continue to blunder along without the aid of unpartisan and authoritative scientific assistance in the administration of justice, no one knows; but all fair persons not conventionalized by provincial legal habits of mind ought, I should think, unite to effect some such advance.¹

Learned Hand, 1911

I. INTRODUCTION

Consider the following situation: Bob is a 37-year-old chain smoker with a family history of lung cancer. As a municipal electrician for 18 years, he came into routine contact with polychlorinated biphenyls (PCBs), which are industrial chemicals used in electrical transformers. Bob has recently been diagnosed with lung cancer; he believes that it was caused by long-term exposure to PCBs, despite his smoking habit and family history. Unfortunately for Bob, most of the scientific community does not believe that PCB exposure causes lung cancer in humans. But Bob finds two experts, Drs. Schechter and Teitelbaum, who find his claim plausible. Both doctors are tenured medical professors and nationally recognized experts in medical toxicology generally and the effects of PCBs specifically. They cite two sets of studies in support of their conclusion that Bob's cancer could have been caused by PCB exposure; the first found statistically significant associations between PCB exposure and cancer in laboratory mice, while the second set reinterpreted data from several epidemiological studies, concluding that those studies support a causal relationship between PCB exposure and lung cancer. Bob's experts conclude that these studies, taken together, support the inference that PCB exposure can be carcinogenic to humans.

Now answer the following questions:

1. Are Bob's experts actually *experts* in the scientific domain for which they claim to speak? What criteria distinguish an expert from a layperson in a given scientific field, and how can these criteria be applied by a layperson to distinguish genuine experts from pseudo-experts or frauds?
2. Is the methodology that Bob's experts rely on reliable? Is it scientific? Do the studies they cite adequately support their conclusions about PCBs' causal role in human oncogenesis?

1. Parke-Davis & Co. v. H.K. Mulford Co., 189 F. 95, 115 (S.D.N.Y. 1911).

3. Assume for the moment that you find Schechter and Teitelbaum's method sufficiently reliable to consider. Is it *convincing*? That is, do you believe that it is more likely than not true that PCBs can cause cancer in humans? What if there were two other doctors, equally well-credentialed, who read the same studies and came to the opposite conclusion? How should you choose between the two sides?

The legally trained reader could be excused for wondering if she has picked up a journal of toxicology or oncology by mistake. Lacking technical training, a lawyer can hardly hope to make sufficient sense of the intricacies of these fields to take an informed view of the questions presented. And the hypothetical dissenters introduced in the third question only confuse the matter further—how can the lay reader hope to make an informed choice between the opposing views of qualified experts? Surely disagreements about these technical matters are better referred to medical researchers, with doctoral degrees and years of lab experience; what could the scientific layperson, legally trained or otherwise, possibly add? And yet, judges and juries engage in this task every day. The work of courts demands that they evaluate the claims of expert witnesses in scientific fields as varied as epidemiology, economics, forensic identification, and civil engineering, among many others. Indeed, the example offered above is a slightly modified version of the expert dispute at issue in one of the Supreme Court's trilogy of cases on the admissibility of expert witness testimony.²

Courts routinely hear expert testimony in scientific fields in which judges and juries lack specialized training.³ How, then, can legal decision makers determine the scientific truth from the adversarial presentation of expert witness testimony? Most of the scholarship addressing this question finds that they simply cannot; they make decisions by relying on heuristics and stereotypes rather than substantive evaluation of the contending experts' scientific views.⁴ One scholar has declared this situation a constitutional

2. Gen. Elec. Co. v. Joiner, 522 U.S. 136 (1997).

3. This Article addresses the problem of epistemic competence specifically with respect to *scientific*, as opposed to technical or other specialized knowledge. This is so for two reasons. First, the problem of epistemic competence seems most acute with respect to scientific expert testimony. Second, the problem appears more readily solvable if addressed in the narrower frame of scientific evidence.

4. See *infra* Section III.B–C.

crisis, arguing that the Due Process Clause contains an “intellectual due process” component that requires legal decision makers to possess “epistemic competence” to interpret and apply expert testimony in a rational way.⁵

The problem of epistemic competence has proven far easier to diagnose than to remedy. Judges, lawyers, and academics have spent more than a century proposing reforms intended to make courts more effective at applying scientific evidence to the resolution of legal disputes.⁶ Some of these proposals have mitigated the problem, but none has eliminated it; today’s commentators bemoan courts’ lack of scientific literacy and the partisanship of hired-gun experts just as those of the nineteenth century did. The problem has become intractable.

This Article argues that the intractability of the problem can be traced in large part to the epistemological paradigm by which the conversation has been framed. Scholars working in classical epistemology and the sociology of scientific knowledge have independently concluded that competent judgments on issues of scientific fact can be made only by legal decision makers who possess expertise in the relevant scientific domain.⁷ But when that insight is applied within an atomized epistemological paradigm that can only conceive of individual, limited human minds as epistemic agents—entities capable of possessing knowledge and mental states—only two solutions can exist: either judges and jurors must become omniscient, or courts must be carved up into specialist institutions resolving legal disputes involving only the scientific domain in which the specialist decision makers are proficient. Neither solution is feasible, and so much of the conversation of the past century has focused on mitigation measures within the individualist epistemological paradigm. A full solution has seemed out of reach.

Recent work in social epistemology provides a more fruitful perspective. Individual human minds cannot possess expertise in

5. Scott Brewer, *Scientific Expert Testimony and Intellectual Due Process*, 107 YALE L.J. 1535 (1997); cf. Jennifer L. Mnookin, *Idealizing Science and Demonizing Experts: An Intellectual History of Expert Evidence*, 52 VILL. L. REV. 763, 766 (2007) (“*Daubert* [*v. Merrell Dow Pharmaceuticals, Inc.*, 509 U.S. 579 (1993)] . . . underscores the question of how judges understand science: whether they have the competence to evaluate it rationally, and whether their methods, heuristics, instincts and abilities will permit them adequately to distinguish expert testimony that the fact-finder *should* hear from expert evidence that should be barred for lack of proof of validity.”).

6. See *infra* Section III.E.

7. See *infra* Section III.B.

every scientific domain relevant to litigation. Institutions, however, can come much closer. We routinely think of institutions as capable of possessing knowledge and mental states. We worry that Facebook *knows* too much about our private lives, say that Wells Fargo *knew or should have known* that its employees were creating fraudulent bank accounts, or question whether Russia *intended* to influence the 2016 presidential election.⁸ Social epistemology examines the epistemic systems of institutions, exploring the mechanisms by which collective knowledge is generated.

This Article advocates a shift in epistemological perspective from the individual to the institution. Refocusing the discussion on the institution of the court provides a way to satisfy the condition that the legal decision maker—the court itself—possess scientific expertise. It will sketch a social epistemological solution to the problem of epistemic competence, which would bring scientific expertise into the court by (1) creating an administrative office staffed by individuals with expertise in a range of scientific domains that most commonly arise in litigation; and (2) incorporating those experts' knowledge into the institution of the court. These “scientific adjuncts” would have the legal authority to decide questions requiring the application of scientific expertise during the pretrial phase and would participate as testifying witnesses at trial. This proposal addresses the demonstrated need for greater reliability in judicial engagement with scientific expertise while preserving, insofar as possible, the structure and normative values served by the existing institutional design of the common law court.

This Article proceeds as follows. Part II provides an overview of the doctrinal framework governing courts' interactions with scientific expertise, specifically the law governing the qualification of expert witnesses, judicial gatekeeping, and factfinding on the basis of expert testimony. Part III examines the problem of epistemic competence and its proposed solutions in greater detail. First, it explains the normative, and arguably constitutional, stakes of the problem and describes how recent converging accounts in classical epistemology and the sociology of scientific knowledge

8. The law, too, conceives of institutions as epistemic agents, for example in its conception of corporations as capable of possessing the mental states necessary for criminal liability. See Mihailis E. Diamantis, *Corporate Criminal Minds*, 91 NOTRE DAME L. REV. 2049 (2016). Indeed, the Supreme Court recently held that some closely held for-profit corporations can claim First Amendment protection for their religious beliefs, as non-profits have long been able to do. *Burwell v. Hobby Lobby Stores, Inc.*, 134 S. Ct. 2751 (2014).

have elucidated the necessary conditions for competent judgment on matters of scientific fact; it then proceeds to survey the empirical literature on courts' competence to evaluate scientific evidence, and finally includes a brief survey of the history of reform proposals intended to mitigate the problem. Part IV explains that the converging insights of classical epistemology and the sociology of scientific knowledge have not yet resulted in a workable solution because the conversation remains constrained by an atomized epistemological paradigm that fails to recognize institutions as epistemic agents. Drawing on insights from social epistemology, it proposes a shift in epistemological perspective and describes a method by which those insights might be applied to create a judicial institution possessing both legal authority and scientific expertise by incorporating scientific experts into the decision-making process as judicial officers. It further describes one method by which this "social-epistemological solution" might be implemented. Part V briefly concludes.

II. THE DOCTRINAL FRAMEWORK OF LAW'S ENCOUNTERS WITH SCIENTIFIC EXPERTISE

Courts engage with expert testimony in three distinct contexts during the course of litigation: (1) expert witness *qualification*; (2) evaluation of the *reliability* of the expert's methodology for the purpose of determining admissibility (i.e., "gatekeeping"); and (3) *factfinding* on the basis of admissible expert testimony. This Part will use the federal system as the paradigm case; state-level deviations from that paradigm are occasionally discussed, but this section is not intended as a comprehensive overview of state departures from the federal model.

Federal Rule of Evidence (FRE) 702 is the principal doctrinal frame for the court's engagements with scientific expertise:

A witness who is qualified as an expert by knowledge, skill, experience, training, or education may testify in the form of an opinion or otherwise if:

- (a) the expert's scientific, technical, or other specialized knowledge will help the trier of fact to understand the evidence or to determine a fact in issue;
- (b) the testimony is based on sufficient facts or data;

(c) the testimony is the product of reliable principles and methods; and

(d) the expert has reliably applied the principles and methods to the facts of the case.⁹

A. *Qualification of Expert Witnesses*

In order to testify as an expert witness, one must be an expert in the relevant scientific domain. Thus, proponents of expert witness testimony bear the burden of demonstrating their proposed expert's qualification by a preponderance of proof.¹⁰ While philosophers and psychologists have long debated the question of what distinguishes "experts" from laypersons,¹¹ the Federal Rules of Evidence largely avoid the nuances of the academic debates. Rule 702 takes a permissive approach to qualification that recognizes a broad range of sources of expertise. Although no empirical studies on the frequency with which proposed experts

9. FED. R. EVID. 702.

10. FED. R. EVID. 104(a); see *Daubert v. Merrell Dow Pharm.*, 509 U.S. 579, 592 (1993). "Preponderance of proof" rather than "preponderance of the evidence" is the correct term because, pursuant to Rule 104(a), the Rules of Evidence do not apply to preliminary questions.

11. See, e.g., David Z. Hambrick et al., *Deliberate Practice: Is That All It Takes to Become an Expert?*, 45 INTELLIGENCE 34, 41 (2014) (finding that "[d]eliberate practice does not explain . . . most of the variance in performance in chess and music"); K. Anders Ericsson, Ralf T. Krampe & Clemens Tesch-Römer, *The Role of Deliberate Practice in the Acquisition of Expert Performance*, 100 PSYCHOL. REV. 363, 400 (1993) (finding that "the differences between expert performers and normal adults reflect a life-long period of deliberate effort to improve performance in a specific domain" rather than differences in innate "talent"); see generally FERNAND GOBET, UNDERSTANDING EXPERTISE: A MULTI-DISCIPLINARY APPROACH (2016) (interdisciplinary overview of acquisition and characteristics of expertise); ANDERS ERICSSON & ROBERT POOL, PEAK: SECRETS FROM THE NEW SCIENCE OF EXPERTISE (2016) (developing deliberate practice model of expertise acquisition); HARRY COLLINS, ARE WE ALL SCIENTIFIC EXPERTS NOW (2014) (articulating a model of epistemic authority for scientific expertise compatible with the diminution of science's social authority in the late twentieth century); HARRY COLLINS & ROBERT EVANS, RETHINKING EXPERTISE (2007) (developing a typology of ubiquitous and specialized expertise); THE PHILOSOPHY OF EXPERTISE (Evan Selinger & Robert P. Crease eds., 2006) (discussing epistemological and theoretical problems in the acquisition of expertise and the identification and epistemic authority of experts).

are deemed qualified exist, Rule 702 establishes a relatively low doctrinal bar for expert qualification.¹²

The language of Rule 702 raises two questions concerning expert qualification: first, what sorts of knowledge can sustain claims of expertise—that is, which domains can a witness be an expert *in*?—and second, what epistemic characteristics distinguish an expert from a layperson? As to the first question, the Rule’s language is quite broad, as has been its application. Rule 702(a) states that an expert’s “scientific, technical, or other specialized knowledge” is admissible if it “will help the trier of fact to understand the evidence or to determine a fact in issue.”¹³ All fields of “specialized knowledge” are thus potential subjects of expert testimony to the extent that they will assist the trier of fact understand the evidence or determine a relevant fact. But replacing one obscure term with another does not really answer the underlying question: what sorts of knowledge does the law recognize as “specialized”? Courts solve that problem by referring to Rule 702’s instrumental language: “specialized” knowledge is that which will assist the trier of fact in its task, generally because it involves some component that is beyond the experience of the typical juror.¹⁴ Thus, courts have recognized fields of knowledge such as the meaning of gang and drug jargon,¹⁵ procedures for the emergency evacuation of disabled individuals,¹⁶ and the

12. Courts have, however, deemed proposed expert witnesses unqualified where the witness’s expertise is too attenuated. *See, e.g.,* *Chapman v. Procter & Gamble Distrib., LLC*, 766 F.3d 1296, 1315 (11th Cir. 2014) (doctor not qualified to testify as expert “because his expertise is hematology and not myelopathy at issue in this case”); *Milne v. USA Cycling Inc.*, 575 F.3d 1120, 1133–34 (10th Cir. 2009) (proposed expert with experience in paved road bike races was not qualified to offer opinion as to standard of care in mountain bike races).

13. FED. R. EVID. 702(a).

14. *See, e.g.,* *United States v. Hill*, 749 F.3d 1250, 1258 (10th Cir. 2014) (“The touchstone of admissibility under Rule 702 is the helpfulness of the evidence to the trier of fact.”). The Advisory Committee’s notes to Rule 702 explicitly encourage this approach, stating that “[w]hether the situation is a proper one for the use of expert testimony is to be determined on the basis of assisting the trier.” FED. R. EVID. 702 Advisory Committee’s notes on 1972 proposed rule.

15. *See, e.g.,* *United States v. York*, 572 F.3d 415, 421–22 (7th Cir. 2009); *United States v. Dukagjini*, 326 F.3d 45, 52–53 (2d Cir. 2002).

16. *E.E.O.C. v. E.I. Du Pont de Nemours & Co.*, 406 F. Supp. 2d 645, 653–54 (E.D. La. 2005), *rev’d in part on other grounds*, 480 F.3d 724 (5th Cir. 2007).

interpretation of foreign law¹⁷ as sufficiently specialized to warrant the certification of expert witnesses.¹⁸

As to the second question, the rules provide no formal definition of “expert,” and approach the subject only obliquely by reference to the types of knowledge that can properly be the subject of expert testimony. Rule 702 provides, by implication, that an expert is one who possesses “scientific, technical, or other specialized knowledge” by virtue of “knowledge, skill, experience, training, or education,” while the Advisory Committee’s notes state simply that “lay testimony ‘results from a process of reasoning familiar in everyday life,’ while expert testimony ‘results from a process of reasoning which can be mastered only by specialists in the field.’”¹⁹ Who, then, can be an expert in a scientific, technical, or other specialized field, and how is the court to distinguish genuine experts from charlatans, novices, or incompetents? Courts have adopted a flexible approach to that question, reflecting the diverse types of specialized knowledge to which the rule applies as well as the diverse methods by which expertise can be acquired. Many domains in which courts have recognized expertise lack formal credentialing mechanisms; even in domains in which credentialing authorities exist, courts have recognized expertise on the basis of professional experience even where the proposed expert lacks the relevant credential.²⁰ Outside of the area of forensic science, however, formal credentials appear to be a *de facto* requirement for qualification as an expert in a scientific domain; this Article is unaware of any cases in which a court has recognized an individual uncredentialed in a scientific domain as a qualified expert, despite sociological evidence suggesting that uncredentialed scientific expertise does exist.²¹

17. *Universe Sales Co. v. Silver Castle, Ltd.*, 182 F.3d 1036, 1037–39 (9th Cir. 1999); see FED. R. CIV. P. 44.1 (“In determining foreign law, the court may consider any relevant material or source, including testimony, whether or not submitted by a party or admissible under the Federal Rules of Evidence.”).

18. Of course, not *all* knowledge is “specialized.” See, e.g., *Hatch v. State Farm Fire & Cas. Co.*, 930 P.2d 382, 389 (Wyo. 1997) (witness not permitted to testify as expert in how a “good neighbor” would act in handling plaintiff’s insurance claim).

19. FED. R. EVID. 701(a); FED. R. EVID. 701 Advisory Committee’s notes to 2000 amendment (quoting *State v. Brown*, 836 S.W.2d 530, 549 (Tenn. 1992)).

20. See, e.g., *United States v. Council*, 777 F. Supp. 2d 1006 (E.D. Va. 2011) (admitting the testimony of fingerprint examiner who lacked professional certification).

21. See Steven Epstein, *The Construction of Lay Expertise: AIDS Activism and the Forging of Credibility in the Reform of Clinical Trials*, 20 SCI. TECH. & HUM. VALUES 408 (1994) (recounting the contributions of

B. *Gatekeeping: Assessing the Reliability of Expert Methodology*

If the expert is qualified, the court may be called upon to perform a “gatekeeping” task, that is, to evaluate the reliability of the methodology underlying the expert’s anticipated testimony. Unlike the threshold issue of expert qualification, gatekeeping is generally undertaken only upon motion of the opposing party. A few decisions have held that a court may engage in gatekeeping review *sua sponte*,²² but the practice remains rare. The admission of expert testimony at trial is thus no guarantee of its reliability, as the decision to seek gatekeeping review is subject to a variety of strategic considerations that may be unrelated to the reliability of an opposing expert’s methodology.²³

Gatekeeping rules are intended to ensure that the testimony is sufficiently methodologically reliable to warrant its introduction at trial. Two principal doctrinal models of gatekeeping review exist in contemporary law. One largely delegates the question of reliability to an extrajudicial community of acknowledged experts, while the other requires courts to make independent assessments of experts’ methodology on the basis of (contested) criteria of scientific validity. Both have been subject to extensive criticism, and neither provides a fully satisfactory framework for effectively distinguishing reliable scientific methodology from pseudoscience, non-science, or incompetent science.

1. The Sporting Theory

In the nineteenth and early twentieth centuries, the law of gatekeeping was essentially an absence of law. The partisan expert witness emerged as a recognizable figure during the late eighteenth and early nineteenth centuries, as the practice of specialized juries and court-appointed, non-partisan experts gave way to party-

uncredentialed activists toward AIDS research); Brian Wynne, *Sheepfarming after Chernobyl: A Case Study in Communicating Scientific Information*, 31 ENV’T: SCI. & POL’Y FOR SUSTAINABLE DEV. 10 (1989) (finding that Cumbrian sheep farmers’ insights into local ecology and animal husbandry were ignored by scientists and bureaucrats attempting to mitigate harm from fallout after the Chernobyl nuclear disaster).

22. See *Miller v. Baker Implement Co.*, 439 F.3d 407 (8th Cir. 2006); *O’Conner v. Commonwealth Edison Co.*, 13 F.3d 1090 (7th Cir. 1994).

23. See, e.g., Greg Ryan, *5 Definite No-Nos for Daubert Motions*, LAW360 (Apr. 9, 2013, 9:14 PM), <https://www.law360.com/articles/431334/5-definite-nos-for-daubert-motions> (advising practitioners that the “strategy” of filing a gatekeeping motion “is not always wise, in large part because judges are quick to anger when they feel a motion isn’t legitimate or efficient”).

retained partisans.²⁴ By the middle of the nineteenth century, expert testimony had achieved its more or less contemporary form, but the law had developed no particularized rules governing its admissibility.²⁵ Mnookin applies Roscoe Pound's account of the "sporting theory of justice" to the 19th century evidentiary regime, under which putative expert testimony was freely admissible and cross-examination served as the principal check against spurious claims of epistemic authority.²⁶ As long as the proposed expert's testimony was relevant and the expert was qualified, parties generally were free to introduce the testimony of experts as they saw fit.

By the end of the nineteenth century, the sporting theory had produced a crisis of confidence in the courts. The "rising tide" of scientific and technical cases during the Industrial Revolution increased the frequency with which expert witnesses were involved in litigation, and experts' status as partisan witnesses placed them in adversarial positions that undermined the public's confidence in scientific objectivity.²⁷ "Such cases, where the court and the jury found themselves again and again in the paradoxical position of being expected to decide on issues about which they knew absolutely nothing except what the clearly partisan scientific experts had told them, appalled the courts."²⁸ The public was also

24. See, e.g., Mnookin, *supra* note 5, at 767–70; TAL GOLAN, LAWS OF MEN AND LAWS OF NATURE: THE HISTORY OF SCIENTIFIC EXPERT TESTIMONY IN ENGLAND AND AMERICA 6–7, 18–22 (2007); Learned Hand, *Historical and Practical Considerations Regarding Expert Testimony*, 15 HARV. L. REV. 40–41 (1901).

25. GOLAN, *supra* note 24, at 110–23; Mnookin, *supra* note 5, at 769–70.

26. Jennifer L. Mnookin, *Expert Evidence, Partisanship, and Epistemic Competence*, 73 BROOK. L. REV. 1009, 1015 (2008); see Roscoe Pound, *The Causes of Popular Dissatisfaction with the Administration of Justice*, 14 AM. L. 445 (1906).

27. GOLAN, *supra* note 24, at 52; see *id.* at 52–106; cf. *Winans v. N.Y. & Erie R.R. Co.*, 62 U.S. 88, 101 (1858) (“[E]xperience has shown that opposite opinions of persons professing to be experts may be obtained to any amount.”).

28. *Id.* at 88; see Mnookin, *supra* note 5, at 771–72 (surveying court decisions critical of expert witness testimony); Hand, *supra* note 24, at 54–55. This history, along with the century-long academic conversation surveyed in Section III.C, *infra*, stands in opposition to recent “debunking” arguments that the problem of epistemic competence is of recent origin. See Barbara Pfeffer Billauer, Daubert *Debunked: A History of Legal Retrogression and the Need to Redefine “Science” in Law*, 21 SUFFOLK J. TRIAL & APP. ADVOC. 1, 49–55 (2016). Billauer argues, on the basis of two cherry-picked appellate opinions and a string citation of unanalyzed jury decisions, that courts of the early twentieth century had no problem interpreting and applying expert scientific evidence.

appalled. Mnookin recounts that by the late nineteenth century, “[e]xpert witnesses were denounced in legal journals and by the popular press. They were attacked for routinely contradicting one another, accused of confusing rather than aiding juries, and lambasted for being partisan ‘hired guns,’ paid by and thus partial to one party or the other.”²⁹ A new approach was needed, though it would not be developed for several decades.

2. *Frye v. United States* and Delegatory Gatekeeping

The D.C. Circuit’s 1923 decision in *Frye v. United States* was an early effort to constrain the free-for-all sporting theory, and it remains influential.³⁰ *Frye* involved an appeal from a conviction of second-degree murder. At trial, the defendant sought to introduce testimony concerning the results of a “systolic blood pressure” test, an early form of lie detector.³¹ The trial court granted the prosecution’s motion to exclude the evidence, and the D.C. Circuit affirmed that decision. The principles underlying scientific or technical evidence, the court held, “must be sufficiently established to have gained general acceptance” by the relevant scientific community in order to be admissible at trial.³² *Frye*’s “general acceptance” standard became the controlling test for the admissibility of scientific and technical evidence for much of the twentieth century, although, in reality, the sporting theory remained the *de facto* standard at least until courts began to apply *Frye* more stringently in the 1970s.³³

The sources identified in this footnote, none of which Billauer cites, belie that claim.

29. Mnookin, *supra* note 5, at 771.

30. 293 F. 1013 (D.C. Cir. 1923).

31. *Id.* at 1013–14. For an engaging history of the development of the systolic blood pressure test by William Marston and its ultimate rejection by the D.C. Circuit in *Frye*, see Jill Lepore, *On Evidence: Proving Frye as a Matter of Law, Science, and History*, 124 YALE L.J. 1092 (2015), and JILL LEPORE, *THE SECRET HISTORY OF WONDER WOMAN* 72–78 (2014).

32. *Frye*, 293 F. at 1014.

33. Michael J. Saks, *Judging Admissibility*, 35 J. CORP. L. 135, 139 (2009); Mnookin, *supra* note 26, at 1016. The first federal appellate court decision to adopt the *Frye* test appears to have been in *Barrel of Fun, Inc. v. State Farm Fire & Cas. Co.*, 739 F.2d 1028, 1031 (5th Cir. 1984); see Michael H. Gottesman, *From Barefoot to Daubert to Joiner: Triple Play or Double Error?*, 40 ARIZ. L. REV. 753, 755 n.11 (1998). Indeed, some recent scholarship argues that courts maintained a *laissez-faire* attitude toward gatekeeping until the early 1990s. JACK FISHER, *SILICONE ON TRIAL: BREAST IMPLANTS AND THE POLITICS OF RISK* 222 (2015); see Billauer, *supra* note 28, at 26. An empirical study found, paradoxically, that “general acceptance” was used only rarely (5% of the sample

The *Frye* test delegates the question of reliability to a community of recognized experts. The court's task consists only in identifying the relevant community and determining whether it generally accepts the methodology at issue. While *Frye* imposes a lower epistemic burden than the more demanding *Daubert* standard,³⁴ it does nevertheless make several substantial demands of judges. Perhaps the knottiest problem posed by *Frye* is the definition of the relevant community: if the reliability inquiry is a matter of nose counting, whose noses are to be counted?³⁵ This is a problem of great practical import because domains or sub-disciplines often have disciplinary axioms and epistemic norms that lead them to view the reliability of a particular methodology quite differently. Closely related to the problem of identifying the relevant community is the problem of identifying its boundaries. Should the community be defined broadly or narrowly? As Cole and Edmond observe, “[c]ontestation over whether the [reference community] should be construed narrowly or broadly is endemic to a *Frye* analysis [N]arrow interpretations tend to favor proponents of contested evidence whereas broad interpretations tend to favor opponents and exclusion.”³⁶

The inherent ambiguity of the reference community points to yet another epistemic challenge in the *Frye* standard: the operationalization of the ambiguous phrase “general acceptance.” How “general” must the community’s acceptance be to establish the scientific reliability of the methodology at issue?³⁷ A “general acceptance” threshold of, say, 90% of the reference community will prove quite conservative in practice, limiting admissibility to

cases) between 1980 and 1993 and became much more prominent *after* the Supreme Court’s decision in *Daubert v. Merrell Dow. Pharm., Inc.*, 509 U.S. 579 (1993). LLOYD DIXON & BRIAN GILL, CHANGES IN THE STANDARDS FOR ADMITTING EXPERT EVIDENCE IN FEDERAL CIVIL CASES SINCE THE *DAUBERT* DECISION 44 (2001).

34. See *infra* note 41 and accompanying text.

35. See Paul C. Giannelli, *The Admissibility of Novel Scientific Evidence: Frye v. United States, A Half-Century Later*, 80 COLUM. L. REV. 1197, 1208–10 (1980).

36. Simon A. Cole & Gary Edmond, *Science Without Precedent: The Impact of the National Research Council Report on the Admissibility and Use of Forensic Science Evidence in the United States*, 4 BRIT. J. AM. LEGAL STUD. 585, 606 (2015).

37. See, e.g., Marc S. Klein, *Expert Testimony in Pharmaceutical Product Liability Actions*, 45 FOOD DRUG COSM. L.J. 393, 421–22 (1990); Pamela A. Wilk, *Expert Testimony on Rape Trauma Syndrome: Admissibility and Effective Use in Criminal Rape Prosecution*, 33 AM. U. L. REV. 417, 432 (1984); Giannelli, *supra* note 35, at 1210–11.

matters of near-unanimous consensus in the field and excluding much well-supported but nevertheless speculative scientific knowledge. In conjunction with the burden of proof, particularly in civil litigation, the effect of a high threshold for general acceptance will generally have an anti-plaintiff effect, excluding much evidence on which civil plaintiffs might rely to establish an element by a preponderance of the evidence. Conversely, a lower threshold opens the courtroom to less universally accepted methodologies, increasing the risk that legal decisions will be influenced by unsound “junk science.”

Notwithstanding these difficulties, the *Frye* standard held sway over the law of expert witness admissibility in most states for much of the mid-twentieth century. It is still the law in some states today.³⁸

3. Rule 702 and the *Daubert* Trilogy

In 1975, Congress implemented the Federal Rules of Evidence by statutory enactment.³⁹ Rule 702, as originally adopted, stated that “[i]f scientific, technical, or other specialized knowledge will assist the trier of fact to understand the evidence or to determine a fact in issue, a witness qualified as an expert by knowledge, skill, experience, training, or education, may testify thereto in the form of an opinion or otherwise.”⁴⁰ In *Daubert v. Merrell Dow Pharmaceuticals, Inc.*, the Supreme Court held that Rule 702 superseded the *Frye* test and that “general acceptance” was no longer a necessary or sufficient condition of admissibility, though it remains relevant.⁴¹ Under *Daubert’s* interpretation, courts themselves are to determine the scientific reliability of a proposed expert’s methodology by reference to such indicia of reliability as the methodology’s falsifiability, its known or potential error rate, its reliance on peer-reviewed publications, and, as one factor among the others, general acceptance by the scientific community.⁴²

38. See *infra* note 44.

39. Pub. L. No. 93-595 (1975).

40. FED. R. EVID. 702.

41. 509 U.S. 579, 594-97 (1993).

42. *Id.* at 593-94. A decade earlier, the Court had stated that the Federal Rules of Evidence “anticipate that relevant, unprivileged [expert] evidence should be admitted and its weight left to the factfinder.” *Barefoot v. Estelle*, 463 U.S. 880, 898 (1983). *Daubert* made no reference to *Barefoot* and offered no explanation for the apparent contradiction between the gatekeeping regime it read into Rule 702 and the sporting theory the Court had seemingly approved in the earlier decision. See Gottesman, *supra* note 33, at 755-56; Paul C. Giannelli,

Daubert places a greater epistemic burden on judges tasked with determining the reliability of proposed expert testimony; indeed, Chief Justice Rehnquist complained in dissent that *Daubert* forces judges to become “amateur scientists,” though in reality the task is more akin to that of an amateur philosopher of science.⁴³

Chief Justice Rehnquist’s reservations notwithstanding, the *Daubert* majority’s decision remains the controlling interpretation of Rule 702, and its approach has been adopted, at least partially, by most state judiciaries.⁴⁴ In two subsequent cases, the Supreme Court clarified the scope of the *Daubert* standard. In *General Electric Co. v. Joiner*, the Court held that the *Daubert* standard applies to a proposed expert’s methods and conclusions as well as

Daubert: *Interpreting the Federal Rules of Evidence*, 15 CARDOZO L. REV. 1999, 2020–21 (1993). A likely explanation is that the problem of “junk science” in litigation had become more salient in the decade between *Barefoot* and *Daubert*. See Gottesman, *supra* note 33, at 756–58; see generally PETER W. HUBER, GALILEO’S REVENGE: JUNK SCIENCE IN THE COURTROOM (1993).

43. *Daubert*, 509 U.S. at 601 (Rehnquist, C.J., dissenting); see David S. Caudill & Richard E. Redding, *Junk Philosophy of Science?: The Paradox of Expertise and Interdisciplinarity*, 57 WASH. & LEE L. REV. 685, 685 (2000) (expressing “dissatisf[action] with the limited philosophical framework that predominates in the judicial and scholarly accounts of the validity and admissibility of scientific testimony”); Brewer, *supra* note 5, at 1547 (“[I]n interpreting Rule 702’s reference to ‘scientific knowledge,’ the Court set itself the paradigmatically *philosophical* task of exploring the criteria of the concept of science.”).

The distinction between the scientist and the philosopher of science is summed up by Richard Feynman’s possibly apocryphal remark that “[t]he philosophy of science is as useful to scientists as ornithology is to birds.” See Ben Trubody, *Richard Feynman’s Philosophy of Science*, PHILOSOPHY NOW (2016), https://philosophynow.org/issues/114/Richard_Feynmans_Philosophy_of_Science (last visited Mar. 20, 2018). Though often construed as disparaging to philosophers of science, Feynman’s analogy is apt; what he perhaps failed to consider is that, if one wants to know whether a particular specimen is a bird, one is wiser to consult an ornithologist than a cockatiel.

44. In 2012, Faigman et al. counted 28 states adopting *Daubert*, six states and the District of Columbia following a state law approximation of *Daubert*, nine states rejecting *Daubert*, and eight states following a mixed approach. DAVID L. FAIGMAN ET AL., MODERN SCIENTIFIC EVIDENCE: THE LAW AND SCIENCE OF EXPERT TESTIMONY § 4:21 (2012). The Supreme Court of California’s decision in *Sargon Enters. v. Univ. of S. Cal.*, 55 Cal. 4th 747, 772 n.6 (2012) appears to have adopted a *Daubert*-like standard for California, though the decision also explicitly reserved a role for the state’s previous admissibility standard applying *Frye* and *People v. Kelly*, 17 Cal. 3d 24 (1976). See David L. Faigman & Edward J. Imwinkelried, *Wading into the Daubert Tide*: *Sargon Enterprises, Inc. v. University of Southern California*, 64 HASTINGS L.J. 1665, 1680–90 (2012). In *Murray v. Motorola*, 147 A.3d 751, 756 (D.C. App. 2016), the D.C. Court of Appeals adopted the *Daubert* standard.

to her methodology, and that a district court's admissibility decision is reviewable for abuse of discretion.⁴⁵ In *Kumho Tire Co. v. Carmichael*, the Court held that the *Daubert* standard applies to non-scientific "technical" expertise as well as "scientific" expertise—in other words, to all testimony sought to be introduced under Rule 702.⁴⁶ *Kumho Tire* also reiterated that the reliability inquiry is a "flexible" one wherein the individual factors articulated in *Daubert* "may or may not be pertinent" to a particular type of putative expertise.⁴⁷

Daubert has been criticized from a variety of perspectives. Scholars have argued that it relies on an overly narrow and perhaps incoherent conception of scientific knowledge,⁴⁸ that it imposes duties on courts for which they lack epistemic competence to perform,⁴⁹ and that, in practice, *Daubert* has not changed courts' decision-making process with respect to the admissibility of expert testimony.⁵⁰ As we shall see, many of those criticisms are empirically well-founded.⁵¹ Nevertheless, *Daubert* remains firmly established as the dominant gatekeeping paradigm at the federal level and in most state courts.⁵²

C. Factfinding

45. 522 U.S. 136, 146–47 (1997).

46. 526 U.S. 137, 148 (1999); see Margaret Berger, *The Admissibility of Expert Testimony*, in FEDERAL JUDICIAL CENTER, REFERENCE MANUAL ON SCIENTIFIC EVIDENCE 12–36 (3d ed. 2011).

47. 526 U.S. at 150.

48. Several commentators point out that *Daubert* indiscriminately relied upon on Popper's falsificationist conception of scientific knowledge, Hempel's logical empiricism, and the views of social constructivist sociologists without commenting upon or evidently recognizing the incompatibility of these accounts of the nature of scientific knowledge. See, e.g., Barbara Pfeffer Billauer, *Admissibility of Scientific Evidence under Daubert: The Fatal Flaws of Falsifiability and Falsification*, 22 B.U.J. SCI. & TECH. L. 21 (2016); Susan Haack, *An Epistemologist in the Bramble Bush: At the Supreme Court with Mr. Joiner*, 26 J. HEALTH POL. POL'Y & L. 217, 232 (2001) ("[I]f the reference to Popper is a *faux pas*, running Popper together with Hempel . . . is a *faux pas de deux*."); SHEILA JASANOFF, *SCIENCE AT THE BAR: LAW, SCIENCE, AND TECHNOLOGY IN AMERICA* 63 (1997).

49. See, e.g., Brewer, *supra* note 5; Mnookin, *supra* note 5.

50. See, e.g., Billauer, *supra* note 28; A. Leah Vickers, *Daubert, Critique and Interpretation: What Empirical Studies Tell Us about the Application of Daubert*, 40 U.S.F. L. REV. 109 (2005) (citing studies).

51. See *infra* Section III.A.2.

52. See *supra* note 44.

As noted above, the sporting theory continues to play a prominent role in the evaluation of expert evidence after the evidence has passed the expert qualification and gatekeeping stages.⁵³ When evidence has been deemed admissible and is introduced at trial, the legal system relies on the adversarial tools of common-law adjudication—primarily cross-examination, the introduction of competing evidence, and the arguments of counsel—to assist the finder of fact in determining the facts of the case.⁵⁴ At this stage, only a few distinctions exist between the law’s treatment of expert and non-expert testimony.

Most of the Federal Rules of Evidence apply with equal force to expert and non-expert testimony. Expert testimony must be relevant,⁵⁵ and its probative value must not be outweighed by its tendency to, among other things, cause unfair prejudice, confuse the issues, mislead the jury, or cause undue delay.⁵⁶ The hearsay rule is slightly relaxed in the context of expert testimony, in that experts may consider inadmissible evidence in forming the basis of their opinion, and such evidence may be disclosed to the jury if its value in assisting the jury with understanding the expert’s opinion “substantially outweighs” its prejudicial effect.⁵⁷ When the expert testimony has passed gatekeeping review, the only additional expert-specific restriction is Rule 704(b), which prohibits experts from providing an opinion as to whether a criminal defendant possessed a mental state that constitutes an element of a charged crime or defense.

III. INTELLECTUAL DUE PROCESS AND THE INTRACTABLE PROBLEM OF EPISTEMIC COMPETENCE

53. See *supra* Section II.B.1.

54. See Jack Weinstein, *Rule 702 of the Federal Rules of Evidence is Sound; It Should Not Be Amended*, 138 F.R.D. 631, 631 (1991) (“The [FRE] were designed to depend primarily upon lawyer-adversaries and sensible triers of fact to evaluate conflicts.”).

55. FED. R. EVID. 402; *cf.* FED. R. EVID. 702(a) (Expert evidence must “help the trier of fact to understand the evidence or to determine a fact in issue.”).

56. FED. R. EVID. 403.

57. FED. R. EVID. 703. Evidence admitted pursuant to Rule 703 is usually accompanied by a limiting instruction to the effect that it is introduced only to help the jury evaluate the expert’s testimony. See, e.g., *United States v. W.R. Grace*, 504 F.3d 745, 759 n.7 (9th Cir. 2007); FRE 703 Advisory Committee’s notes to 2000 amendment (“If the otherwise inadmissible information is admitted [as demonstrating the basis of an expert’s opinion], the trial judge must give a limiting instruction upon request.”). On the utility of limiting instructions, see *infra* note 149 and accompanying text.

The observation that courts are generally ineffective at interpreting and applying scientific expert testimony is not new; it has been a recurring theme for decades. Jennifer Mnookin observes that “a century’s worth of writing about expert evidence circles around the same themes and consistently reaches the same conclusion: that the use of party-selected expert witnesses in an adversarial legal system is fraught with difficulties.”⁵⁸ This section will begin with the normative foundation of the problem: the claim that due process includes an “intellectual” component that requires a minimum rationality in judicial engagement with expert evidence. It will then survey the theoretical and empirical literature describing the problems of epistemic competence in gatekeeping and factfinding,⁵⁹ and then discuss the past century’s academic conversation and reform proposals.

A. *Intellectual Due Process*

What are the normative stakes of epistemic competence? Why should we be concerned if courts are incapable of reliably applying scientific knowledge to the resolution of legal disputes? In an influential article, Scott Brewer argued that the problem of epistemic competence threatens the legitimacy of the judicial process itself, a claim captured in the concept of “intellectual due process.”⁶⁰

The “central idea” of intellectual due process “is that certain rule-of-law values require epistemic nonarbitrariness in factfinding reasoning, as in other types of reasoning.”⁶¹ Those values condition the legitimacy of a judicial outcome on the integrity of the process by which it was reached; *intellectual* rule-of-law values imply that “epistemic nonarbitrariness in the process of ‘finding’ scientifically discerned facts is a necessary condition of the practical legitimacy of a decision that relies on that factfinding.”⁶² Just as we would

58. Mnookin, *supra* note 26, at 1010; cf. 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, 434 (2014) (“[T]he general state of affairs with regard to the law’s understanding of the methods of science creates substantial obstacles to the coherent use of empirical knowledge gleaned from complex research studies.”).

59. This Article omits a discussion of expert qualification because no empirical studies of judges’ competence at distinguishing qualified from unqualified experts has been undertaken, though the question of qualification is occasionally examined in studies of judicial gatekeeping.

60. Brewer, *supra* note 5, at 1672–77.

61. *Id.* at 1672.

62. *Id.* (emphasis omitted).

reject as illegitimate a verdict in which the court flipped a coin to decide whether the light was red or green, we should reject verdicts in which the factfinder lacks a warranted basis on which to discern the true facts and must either guess or, effectively the same thing, apply unreliable heuristics to adjudicate expert disagreements. This is a matter of justification rather than accuracy; although a fair coin flip will coincide with the color of the light about half the time,⁶³ we do not deem this a rationally warranted process where the correspondence between the finding of fact and the external world is only “accidental[] and arbitrar[y].”⁶⁴ For the same reasons, Brewer argues that we should reject as illegitimate the outcome of a process in which the court lacked competence to reliably determine the scientific facts found, regardless of the substantive correctness of that outcome.⁶⁵

“Intellectual due process” has the ring of Ivory Tower fastidiousness, a concern for the niceties of judicial reasoning that may sound quaint in comparison to more urgent problems of access to, and quality of, legal justice. But beneath Brewer’s esoteric jargon is a problem of immediate consequence: if courts are not able to understand and rationally apply scientific evidence to the resolution of legal disputes, then we have no reason to believe that cases are being decided correctly. The ability of judges and jurors to engage rationally with scientific expertise is thus a matter of grave concern to criminal defendants facing a loss of liberty on the basis of potentially specious methods of forensic identification,⁶⁶ toxic tort plaintiffs seeking compensation for injuries caused by the defendant’s negligence,⁶⁷ and civil defendants facing potentially enormous monetary judgments. Epistemic incompetence also potentially exacerbates the well-documented racial, gender, and other biases in legal decision making.⁶⁸ Decision makers who lack the ability to engage with the

63. Assuming, simplistically, that the light alternates between green and red at equal intervals, and ignoring the time spent on yellow.

64. Brewer, *supra* note 5, at 1677.

65. See *id.* at 1672–73 (citing JOHN RAWLS, A THEORY OF JUSTICE 238–39 (1971)).

66. See, e.g., Jennifer L. Mnookin et al., *The Need for a Research Culture in the Forensic Sciences*, 58 UCLA L. REV. 725 (2010); 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).

67. See, e.g., *Gen. Elec. Co. v. Joiner*, 522 U.S. 136 (1997); see also JOSEPH SANDERS, *BENEDICTIN ON TRIAL: A STUDY OF MASS TORT LITIGATION* (1998).

68. See, e.g., J.D. Levinson et al., *Implicit Racial Bias: A Social Science Overview*, in *IMPLICIT RACIAL BIAS ACROSS THE LAW* (J.D. Levinson & R.J.

substance of an expert disagreement must fall back on heuristic shortcuts to reach a decision; in so doing, they open the door for implicit (or at times explicit) biases to affect the process.⁶⁹ Thus, the capacity of the judicial system to engage effectively with the substance of scientific evidence is a matter of great practical import.

B. Competent Scientific Judgment: A Convergence of Disciplinary Perspectives

Both Brewer's classical epistemological account as well as recent work in the sociology of scientific knowledge on the ontology of scientific expertise arrive via distinct paths to the same conclusion: in order to make warranted judgments in matters involving scientific expertise, legal decision makers must possess expertise in the relevant scientific domain. This section will briefly trace the paths by which these disciplines converge.

1. Brewer's Classical Epistemological Account

Brewer undertakes a detailed epistemological analysis of what the epistemological literature calls the "novice/2-expert" problem.⁷⁰ He asks whether, and under what circumstances, "practical" reasoners like judges and juries can arrive at justified belief by deferring to the testimony of a "theoretical" reasoner with expertise in a scientific field.⁷¹ The problem is compounded by competition between adversarial experts—how can the judge or jury, as the least informed member of the triad, hope to make a rationally justified choice between the views of the two experts? They cannot do so on the basis of substantive evaluations of the experts' positions—"ex hypothesi," Brewer notes, "nonexpert factfinders . . . cannot be convinced by what Aristotle called the reason (*logos*) behind an expert judgment because they cannot understand those substantive arguments."⁷² Non-experts are necessarily confined to alternative methods of judgment.

Smith eds., 2011); A.G. Greenwald & L.H. Krieger, *Implicit Bias: Scientific Foundations*, 94 CAL. L. REV. 945 (2006).

69. See *infra* Section III.C.2 (surveying empirical literature).

70. Brewer, *supra* note 5; cf. Melissa Lane, *When the Experts Are Uncertain: Scientific Knowledge and the Ethics of Democratic Judgment*, 11 EPISTEME 97, 98 (2014); Alvin I. Goldman, *Experts: Which Ones Should You Trust?*, 63 PHIL. & PHENOM. RES. 85, 90 (2001).

71. Brewer, *supra* note 5, at 1593–96.

72. *Id.* at 1624.

Brewer considers four approaches that non-expert factfinders may take to make judgments on the basis of expert testimony, but ultimately finds that none of these approaches is sufficient to sustain a warranted judgment about the scientific domain.⁷³ The first of these is simply the direct second-guessing of an expert's judgment by the lay judge. Brewer quickly discounts this "obviously unsatisfactory solution" while noting the irony that *Daubert* effectively demands such second-guessing by federal gatekeepers.⁷⁴ The remaining three methods rely on proxies or "second-order" characteristics⁷⁵ in place of substantive engagement with the scientific question. Brewer considers (1) the use of general canons of rationality; (2) evaluation of the expert's demeanor; and (3) reliance on the expert's credentials as an indication of genuine expertise. Canons of rationality, such as the avoidance of self-contradiction and the distinction between causation and nonprevention, are generally inadequate because "only a relatively small percentage" of failures of general rationality will be sufficiently obvious for a layperson to identify.⁷⁶ Demeanor is simply arbitrary; "we have no reason to believe that an expert witness's persuasive demeanor has any particular connection to the epistemic warrant for what the witness asserts."⁷⁷ Finally, reliance on an expert's credentials raises the problems of *regress* and *underdetermination*. The regress problem is simply the problem of how a non-expert could identify the indicia of expertise. The obvious answer—credentials or other recognition by some acknowledged group of experts—seems question-begging: how shall that group itself be identified, other than by reference to some further group of meta-experts, and so on ad infinitum?⁷⁸ Even if the regress problem were solved, an additional issue is underdetermination—it is often the case that opposing experts' credentials are more or less evenly matched, in which case this proxy cannot assist the novice in selecting the expert to whom to defer.⁷⁹

73. *Id.* at 1616–30.

74. *Id.* at 1619–20.

75. See Lane, *supra* note 70, at 98.

76. Brewer, *supra* note 5, at 1620–21. For example, failures in rationality in an expert's treatment of complex statistical evidence are unlikely to be apparent to the factfinder. *Id.*

77. *Id.* at 1623.

78. *Id.*

79. *Id.* at 1630. Underdetermination is the more serious difficulty; regress is amenable to a solution that might be dissatisfactory to an epistemological purist but works well enough in practice. The "sociologically minded" rely on

All of this leads Brewer to a “moderately skeptical” conclusion: “when faced with competing, sincere, and roughly equally well-credentialed experts . . . a nonexpert will on average do no better in selecting which scientific expert to believe than one would by tossing a coin.”⁸⁰ In such circumstances, a judge who lacks substantive expertise in the scientific domain cannot reach a non-arbitrary judgment about a question of scientific fact.

Having diagnosed the source of the problem, Brewer offers a deceptively simple solution. If warranted judgments about matters of scientific fact can be made only by individuals with expertise in the scientific domain, then we should ensure that legal decision makers possess scientific expertise. Brewer proposes a “two-hat” model of adjudication, whereby “one and the same decisionmaker has both legal legitimacy . . . and epistemic competence with the basic formal tools of scientific analysis.”⁸¹ Only by placing legal authority and scientific expertise in the same decision maker, he argues, can legal decisions satisfy the demand of intellectual due process.⁸²

2. Sociological Ontology of Scientific Expertise

What is expertise? What does it mean to be an expert? How can the existence of expertise be reconciled with the social component of scientific consensus building and our normative commitment to popular self-government? In a book-length treatment of the subject, Collins and Evans produced a typology of expertise and examined the gradations and functions of each

the “conventional markers of expertise—prestigious journals, university affiliations, advanced degrees, and so on—” to break the regress. Simon A. Cole, *Don’t Shoot the Messenger by One of the Messengers: A Response to Merlino et al.*, 45 TULSA L. REV. 111, 113 (2009); see also Charlie Stiernberg, *Science, Patent Law, and Epistemic Legitimacy: An Empirical Study of Technically Trained Federal Circuit Judges*, 27 HARV. J. L. & TECH. 279, 297 n.119 (2013) (“[C]redentials may serve as a reasonable basis for the second-order decisions regarding which individuals should be appointed to make first-order decisions (regarding competing scientific expert claims)”; Arti K. Rai, *Specialized Trial Courts: Concentrating Expertise on Fact*, 17 BERKELEY TECH. L.J. 877, 894 (2002). Brewer emphasizes underdetermination over regress—it is when the “underdetermination condition” is satisfied that non-expert judgment is effectively arbitrary. Brewer, *supra* note 5, at 1630–34, 1671.

80. Brewer, *supra* note 5, at 1670–71.

81. *Id.* at 1677.

82. *Id.* at 1677–78. We will return to the two-hat model and its failure to resolve the problem of epistemic competence in Section IV.A.

type.⁸³ Their study reveals certain necessary conditions for the acquisition and application of expertise that reinforce Brewer's epistemological conclusions. Collins and Evans conclude, like Brewer, that individuals can reliably evaluate claims of scientific expertise only when they themselves possess substantive expertise in the scientific domain.

83. COLLINS & EVANS, *supra* note 11. This project is in furtherance of what Collins and Evans describe as the "third wave" of science studies. See Harry Collins & Robert Evans, *The Third Wave of Science Studies: Studies of Expertise and Experience*, 32 SOC. STUD. SCI. 235 (2002) [hereinafter Collins & Evans, *Third Wave*]. The first wave crested during the 1940s through the early 1960s and is best characterized by the work of Robert Merton. See generally ROBERT K. MERTON, *THE SOCIOLOGY OF SCIENCE* (Norman W. Storer ed. 1973); Collins & Evans, *Third Wave*, at 237–38. The first wave imbibed the optimism of the Atomic Age; it accepted more or less uncritically scientific positivism and scientists' claims to privileged access to truth. *Id.* at 239. The result was a top-down model of epistemic authority in which the social contingency of scientific consensus building was ignored and scientific hegemony over questions of technical policy went unquestioned. *Id.* The second wave began, roughly, with the publication of Thomas Kuhn's *THE STRUCTURE OF SCIENTIFIC REVOLUTIONS* (1962) and is best characterized by that work. It emphasized the contingency of scientific consensus building and the social construction of scientific facts "through continual negotiation and renegotiation among relevant bodies of scientists." Sheila Jasanoff, *What Judges Should Know About the Sociology of Science*, 77 JUDICATURE 77, 78 (1993). The second wave opened up the social dynamics of constructed scientific consensus, denied scientists' epistemic privilege, and emphasized bottom-up forms of knowledge and expertise. See, e.g., Brian Wynne, *May the Sheep Safely Graze? A Reflexive View of the Expert-Lay Knowledge Divide*, in RISK, ENVIRONMENT AND MODERNITY: TOWARDS A NEW ECOLOGY (Scott Lash, Bronislaw Szerszynski & Brian Wynne eds. 1996); Wynne, *supra* note 21.

The second wave punctured the myth of infallibility around science and deflated scientists' claims to unique epistemic authority. But by the early 2000s, some second wave theorists grew concerned that the work had moved so far in the direction of demystifying science that no space remained for epistemic differentiation of any sort. See, e.g., Bruno Latour, *Why Has Critique Run Out of Steam? From Matters of Fact to Matters of Concern*, 30 CRITICAL INQUIRY 225 (2004). In inaugurating the third wave of science studies, Collins and Evans lamented that "[b]y emphasizing the ways in which scientific knowledge is like other forms of knowledge, sociologists have become uncertain about how to speak about what makes it different; in much the same way, they have become unable to distinguish between experts and non-experts." Collins & Evans, *Third Wave* at 239. The goal of the third wave was to bring the insights of both previous waves together: "to treat expertise as 'real,' and develop a 'normative theory of expertise.'" *Id.* at 237. The third wave would reclaim the conceptual space for epistemic authority that was diminished by the second wave's emphasis on social construction and demystification but would do so without succumbing to the first wave's naïve positivism. See COLLINS & EVANS, *supra* note 11, at 15.

Collins and Evans identify three broad categories of expertise: *ubiquitous expertise*, which consists of the specialized skills, such as native language fluency, possessed by nearly all members of a society; *specialized expertise*, which refers to substantive expertise in esoteric areas possessed by only a relative few, including expertise in the scientific domains;⁸⁴ and *meta-expertise*, which refers to the ability to distinguish genuine from spurious claims of specialized expertise.⁸⁵ Ubiquitous and specialized expertise require a form of “tacit knowledge,” or “[t]he deep understanding one can only gain through social immersion in groups who possess it.”⁸⁶ Specialized tacit knowledge thus has an intrinsically social component; it cannot be achieved from a review of the domain’s primary literature alone.⁸⁷

Reliable application of meta-expertise also requires specialist tacit knowledge. Collins and Evans distinguish between *internal* and *external* meta-expertise, the distinction turning on whether the judge possesses expertise in the domain.⁸⁸ A judge applying external meta-expertise must rely on the “social discrimination . . . one gains in a democratic society as one learns to choose between politicians, salespersons, service providers, and so forth” to choose between individuals claiming scientific or technical expertise.⁸⁹ This involves the application of social understanding to evaluate whether the putative expert “appears to have the appropriate scientific demeanor and/or the appropriate location within the social networks of scientists and/or not too much in the way of a political and financial interest in the claim.”⁹⁰ This social understanding is comparable to Brewer’s “other indicia of expertise,”⁹¹ Lane’s “second order assessments,”⁹² and the heuristic thinking discussed in the psychological literature,⁹³ and is subject to the same limitations.⁹⁴ Internal meta-expertise, by contrast, is

84. *Id.* at 15–18.

85. *Id.* at 45.

86. *Id.* at 6; *see id.* at 13 (looking at significance of tacit knowledge for the development of ubiquitous expertise).

87. *Id.* at 14.

88. *Id.* at 45.

89. *Id.* at 15; *see id.* at 45, 69.

90. *Id.* at 45.

91. Brewer, *supra* note 5, at 1539.

92. Lane, *supra* note 70, at 97–98.

93. *See infra* notes 133–134 and accompanying text.

94. COLLINS & EVANS, *supra* note 11, at 51 (“[External meta-expertise] is very unreliable because of the temptation to read too much into stereotypical appearances and stereotyped behavior.”).

more reliable insofar as it is “based on possessing one level or another of the expertise being judged.”⁹⁵ The internal meta-expert can engage directly with the substance of the expert claim; she need not rely on proxies or heuristics. Thus we reach Brewer’s conclusion via another path: in attempting to distinguish between competing claims to scientific expertise, the non-expert must necessarily rely on loose proxies for substantive expertise that are imprecise at best, and perpetuate stereotypes and incentivize bias in the selection of partisan experts and the presentation of expert testimony at worst. Only a judge with substantive expertise in the relevant scientific domain can reliably distinguish genuine from specious claims of expertise.⁹⁶

C. *Empirical Studies of Epistemic Competence*

Theoretical scholars disagree among themselves about the extent to which non-expert judges and juries possess competence to make warranted judgments concerning esoteric matters of scientific fact on the basis of the adversarial presentation of partisan expert testimony.⁹⁷ The more empirically oriented will prefer a data-based approach to the dispute. This section provides an overview of the empirical literature on courts’ engagement with expert evidence, demonstrating that courts indeed struggle both as gatekeepers and factfinders where scientific expertise is involved.

1. Gatekeeping

Daubert inspired many studies assessing the effects of the decision on admissibility rates and gatekeeping practices, as well as judges’ effectiveness as gatekeepers. The results of these studies are varied and to some extent conflicting, but taken as a whole, they support the conclusion that judges generally cannot apply the *Daubert* test with a level of competence necessary to satisfy intellectual due process. Three major themes stand out from the empirical literature on gatekeeping: (1) the adoption of *Daubert* most likely produced no long-term change in expert admission

95. *Id.* at 15.

96. *Id.* at 45.

97. On the skeptical side, see, for example, Brewer, *supra* note 5, at 1679–80. For more optimistic assessments of judicial competence, see Lane, *supra* note 70; Elizabeth S. Anderson, *Democracy, Public Policy, and Lay Assessments of Scientific Testimony*, 8 *EPISTEME* 144, 146–51 (2011); John Monahan & Laurens Walker, *Social Authority: Obtaining, Evaluating, and Establishing Social Science in Law*, 134 *PENN. L. REV.* 477, 508–12 (1986).

rates, though it did reverse a short-term uptick in the admission of questionable expert testimony that was underway in the early 1990s; (2) *Daubert* increased courts' and parties' attention to the issue of reliability; and (3) courts are generally incapable of applying the *Daubert* factors reliably and often do not apply them at all when ruling on motions to exclude expert evidence.

Perhaps the most surprising result of the empirical studies, given the endless ink that has been spilled in debates between advocates of the *Frye* and *Daubert* standards, is that the *Daubert* decision appears to have made little long-term difference in rates of admissibility of scientific evidence.⁹⁸ This statement requires a bit of qualification, but it appears to hold true at least on average over the long term. In a comprehensive study sponsored by the RAND Institute for Civil Justice, Dixon and Gill examined 399 decisions on motions to exclude expert evidence in civil cases between 1980 and 1999.⁹⁹ They found that in the immediate aftermath of *Daubert*, from 1993 through 1997, rates of exclusion of expert witness testimony increased, and then began to decline.¹⁰⁰ Billauer, however, places this upward trend into a broader context.¹⁰¹ She points out that in the three years prior to *Daubert*, admission rates had risen considerably as courts were increasingly allowing “junk science” into the courtroom.¹⁰² Across a ten-year time horizon, the exclusion rate settled back and even fell below mid-1980s levels.¹⁰³ Most other studies reach the same conclusion.¹⁰⁴ As Waters and

98. This does not mean, of course, that the *quality* of evidence has been unchanged. As we will see below, scholars agree that *Daubert* increased courts' and lawyers' awareness of issues of reliability and resulted in more motions to exclude unreliable evidence. See *infra* notes 106–111. Unfortunately, it is nearly impossible to measure the quality of evidence introduced, or even to operationalize the concept of “quality” in a domain-general way, and this author is aware of no study that attempts to do so.

99. DIXON & GILL, *supra* note 33.

100. *Id.* at 17–18.

101. Billauer, *supra* note 28, at 13–17.

102. *Id.* at 16; see HUBER, *supra* note 42.

103. Billauer, *supra* note 28, at 15–16.

104. See Edward K. Cheng & Albert H. Yoon, *Does Frye or Daubert Matter? A Study of Scientific Admissibility Standards*, 91 VA. L. REV. 471, 498 (2005) (finding that the influence of *Daubert* on removal rates was “vanishingly small” in magnitude and statistically insignificant); Jennifer L. Groscup et al., *The Effects of Daubert on the Admissibility of Expert Testimony in State and Federal Criminal Cases*, 8 PSYCHOL. PUB. POL'Y & L. 339, 345–46 (2002) (study of 693 state and federal criminal appeals cases between 1987 and 1998 found no statistically significant change in overall admissibility rates); but see Andrew Jurs & Scott DeVito, *The Stricter Standard: An Empirical Assessment of Daubert's*

Hodge concluded in a study of Delaware state cases, “the overall impact of *Daubert* has been minimal.”¹⁰⁵

If *Daubert* did not make a significant difference in rates of exclusion, it *did* play a role in focusing courts’ and litigants’ attention on issues of admissibility. Many studies find that *Daubert* increased the frequency with which motions to exclude testimony were made. Dixon and Gill found that the number of motions to exclude began increasing after the *Daubert* decision and continued to rise through each remaining year of their data set.¹⁰⁶ This is consistent with Krafska et al.’s surveys of judges and attorneys, in which a majority of respondents reported that more motions to exclude expert witness testimony were made after *Daubert*.¹⁰⁷ It is also consistent with the survey by Gatowski et al. of 400 state judges, in which 75% of respondents agreed that one purpose of the *Daubert* decision was to exclude “junk science” from the courtroom.¹⁰⁸ Commenting on the results of their own study, Cheng and Yoon note that they are “consistent with the theory that the power of [*Daubert*] was not so much in its formal doctrinal test, but rather in its ability to create greater awareness of the problems of junk science.”¹⁰⁹

Why was *Daubert*’s doctrinal test not more effective? Perhaps because judges neither understand the *Daubert* factors nor apply them consistently. The results of the survey by Gatowski et al. are particularly illustrative of this point. Although 88% of respondent judges stated that falsifiability was a “useful” guideline in assessing the reliability of scientific evidence, only 6% demonstrated a clear understanding of that concept, while 35% gave answers indicating

Effect on Civil Defendants, 62 CATH. U. L. REV. 675, 679 (2012) (finding that *Daubert* is at least perceived by litigants as a stricter admissibility standard).

105. NICOLE L. WATERS & JESSICA P. HODGE, *THE EFFECTS OF THE DAUBERT TRILOGY IN DELAWARE SUPERIOR COURT* 21 (2005).

106. DIXON & GILL, *supra* note 33, at 19.

107. Carol Krafska et al., *Judge and Attorney Experiences, Practices, and Concerns Regarding Expert Testimony in Federal Civil Trials*, 8 PSYCHOL. PUB. POL’Y & L. 309, 329 (2002).

108. Sophia I. Gatowski et al., *Asking the Gatekeepers: A National Survey of Judges on Judging Expert Evidence in a Post-Daubert World*, 25 L. & HUM. BEH. 433, 443 (2001).

109. Cheng & Yoon, *supra* note 104, at 503; *see also* David M. Flores, James T. Richardson & Mara L. Merlino, *Examining the Effects of the Daubert Trilogy on Expert Evidence Practices in Federal Civil Court: An Empirical Analysis*, 34 S. ILL. U. L.J. 533, 562–63 (2009).

that they clearly did *not* understand it.¹¹⁰ The results for error rate were similar; 91% of judges said that error rate is a useful factor, but only 4% gave answers clearly indicating an understanding of the concept, and 10% gave responses evincing a clear lack of understanding.¹¹¹ Other studies indicate that judges are not sensitive to differences in methodological reliability when evaluating admissibility. Kovera and McAuliff conducted an experiment testing state judges' sensitivity to changes in the internal validity of a description of psychological expert testimony in a sexual harassment case.¹¹² They found that judges' admissibility decisions were not significantly affected by manipulations to validity—judges simply could not distinguish between the reliability of various study designs.¹¹³ Wingate and Thornton examined how federal judges apply the *Daubert* standard to expert witness testimony involving industrial/organizational (I/O) psychology in Age Discrimination in Employment Act (ADEA) litigation.¹¹⁴ The judges' responses showed little sensitivity to manipulations of the quality of peer-reviewed support for the expert's conclusions and a pronounced preference for *Frye's* general acceptance test over the other *Daubert* factors.¹¹⁵

Wingate and Thornton's findings comport with a body of empirical evidence showing, first, that judges often avoid applying *Daubert* to motions to exclude evidence; and second, when they do, they show a marked preference for the factors of general acceptance and peer review over falsifiability and error rate. Groscup et al.'s content analysis of state and federal criminal appeals, for example, found that, while the length of courts' discussion of *Daubert* increased with time, the length of their

110. *E.g.*, "I would want to know if the evidence was falsified," "I would look at the results and determine if they are false." Gatowski et al., *supra* note 108, at 445.

111. *Id.* ("I would take into account the number of mistakes that were made and consider that in my admissibility decision."). Despite having the option to ask the interviewer for definitions of each of the *Daubert* factors, only 16% of judges asked for a definition of falsifiability, and only one of 400 judges asked for a definition of error rate. *Id.* at 445, 447.

112. Margaret Bull Kovera & B. D. McAuliff, *The Effects of Peer Review and Evidence Quality on Judge Evaluations of Psychological Science: Are Judges Effective Gatekeepers?*, 85 J. APP. PSYCHOL. 574 (2000).

113. *Id.* at 576.

114. Peter H. Wingate & George C. Thornton, III, *Industrial/Organizational Psychology and the Federal Judiciary: Expert Witness Testimony and the "Daubert" Standards*, 28 L. & HUM. BEH. 97 (2004).

115. *Id.* at 110–11.

discussion of the individual *Daubert* factors was “relatively abbreviated.”¹¹⁶ The most influential factors affecting the decision to admit or exclude expert testimony were those grounded in other provisions of the Federal Rules of Evidence—the evidence’s relevance, its ability to assist the trier of fact, the potential for prejudicial impact, and the expert’s qualifications.¹¹⁷ By Groscup et al.’s estimation, the four *Daubert* factors were the *least* influential factors on the court’s decision, with error rate and falsifiability ranked last.¹¹⁸ The Groscup study was limited to criminal cases, but other studies have found similar effects in non-criminal cases.¹¹⁹ Dixon and Gill, for example, found that judges increasingly referred to non-*Daubert* factors in deciding motions to exclude expert evidence in the years after *Daubert*.¹²⁰ Thus, the *Daubert* factors themselves appear to play a minimal role in the adjudication of motions to exclude expert witness testimony, apparently, at least in part because judges lack epistemic competence to apply them.¹²¹ This, of course, raises questions about what criteria judges *are* using to adjudicate such motions, a fertile area for future research.¹²²

2. Factfinding

With respect to factfinding, the empirical results are varied but, again, generally support the view that courts are not well-equipped

116. Jennifer L. Groscup et al., *The Effects of Daubert on the Admissibility of Expert Testimony in State and Federal Criminal Cases*, 8 PSYCHOL. PUB. POL’Y & L. 339, 365 (2002).

117. *Id.*

118. *Id.*

119. Veronica B. Dahir et al., *Judicial Application of Daubert to Psychological Syndrome and Profile Evidence: A Research Note*, 11 PSYCHOL., PUB. POL’Y, & L. 62, 73–74 (2005) (finding a “strong tendency for judges to continue to rely on more traditional standards such as general acceptance and qualifications of the expert when assessing psychological syndrome and profile evidence . . . [that] probably reflects judges’ relative unfamiliarity with the technical concepts of falsifiability and error rates”); Krafka et al., *supra* note 107, at 323–24 (finding that most common bases for exclusion were irrelevance, lack of qualification, and lack of tendency to assist the trier of fact—only 8% of exclusions cited *Daubert* factors).

120. DIXON & GILL, *supra* note 33, at 40–44.

121. See Billauer, *supra* note 28, at 46 (describing “the current state of affairs [in which] judges just do not have the training or ability to discern the difference between good and bad science”).

122. See Vickers, *supra* note 50, at 143 (“By straying from the reliability factors, judges may be applying inappropriate criteria and rendering inconsistent judgments.”).

to find facts on the basis of expert evidence.¹²³ Most of the empirical studies on the weighing of evidence tend to focus on jurors rather than judges,¹²⁴ though the few studies of judges' ability to find facts on the basis of conflicting expert testimony suggest that, with a few exceptions, they do not perform significantly differently than jurors.¹²⁵ As to jurors, although some scholars argue that claims of epistemic incompetence are entirely baseless,¹²⁶ the empirical evidence is mixed. The available studies suggest that they are neither as incompetent as might be feared, nor as effective as might be hoped, when interpreting scientific expert testimony.

On one hand, expert testimony has been shown to reduce differences between judge and juror evaluations of evidence. Studies have found that the presentation of expert testimony improves the quality of juror decision making in cases involving eyewitness identification,¹²⁷ child sexual abuse,¹²⁸ and workplace sexual harassment,¹²⁹ where "improvement" is measured by the

123. Trial judges themselves have occasionally acknowledged these difficulties, though doing so leaves them open to appellate rebuke. See, e.g., *McClain v. Metabolife Intern., Inc.*, 401 F.3d 1233, 1238 (11th Cir. 2005) (trial judge's denial of *Daubert* motion on the ground that he lacked the scientific knowledge necessary to adjudicate the motion was abuse of discretion).

124. See Valerie Hans, *Judges, Juries, and Scientific Evidence*, 16 J.L. & POL'Y 19, 25 (2007) ("Although political scientists and other scholars have conducted many analyses of judicial decisions and opinions, the research literature on judicial reactions to scientific literature is modest.").

125. See *infra* notes 149–154 and accompanying text.

126. See, e.g., Neil Vidmar & Shari Seidman Diamond, *Juries and Expert Evidence*, 66 BROOK. L. REV. 1121, 1175 (2001) ("Insofar as it can be assessed, there is no evidence that juries are incompetent to evaluate expert testimony."); Marilee M. Kapsa & Carl B. Meyer, *Scientific Experts: Making Their Testimony More Reliable*, 35 CAL. W. L. REV. 313, 327 (1999) ("There is no hard empirical evidence supporting the argument that a lay jury cannot critically evaluate scientific evidence."); Robert D. Myers et al., *Complex Scientific Evidence and the Jury*, 83 JUDICATURE 150, 152–53 (1999) (arguing that juror difficulties with complex evidence are caused by trial process rather than a lack of epistemic competence).

127. Brian L. Cutler, Steven D. Penrod & Hedy R. Dexter, *The Eyewitness, the Expert Psychologist, and the Jury*, 13 L. & HUM. BEH. 311 (1989); Harmon M. Hosch, *A Comparison of Three Studies of the Influence of Expert Testimony on Jurors*, 4 L. & HUM. BEH. 297, 297 (1980).

128. Margaret Bull Kovera et al., *Does Expert Psychological Testimony Inform or Influence Juror Decision Making? A Social Cognitive Analysis*, 82 J. APP. PSYCHOL. 178, 187–88 (1997).

129. Margaret Bull Kovera, Bradley D. McAuliff & Kellye S. Hebert, *Reasoning About Scientific Evidence: Effects of Juror Gender and Evidence*

jury's tendency to decide the case in the same way that a judge would have.¹³⁰ Adversarial presentation has also been found to make jurors more attentive to expert testimony, in comparison to presentation by a court-appointed expert.¹³¹ Finally, despite some scholars' concerns that lay jurors would be overawed by the credentials of expert witnesses and the complexity of their testimony, jurors generally appear to engage critically with expert witness testimony.¹³²

On the other hand, good intentions and genuine effort cannot create epistemic competence in the absence of substantive expertise. Jurors often fail to understand and apply scientific testimony correctly, even when the underlying science itself is relatively clear.¹³³ They also tend to rely on specious proxies for substantive expertise. Krauss and Sales, for example, describe the "heuristic model" of juror decision making, whereby "when the message is difficult to comprehend or complex, individuals rely on cognitive shortcuts or heuristics . . . [that focus] the individual on the perceived expertise and trustworthiness of the communicator rather than the quality of the message."¹³⁴ Other research is more

Quality on Juror Decisions in a Hostile Work Environment Case, 84 J. APP. PSYCHOL. 362, 371 (1999).

130. *Id.* Kovera, McAuliffe, and Hebert introduce this metric in making the point that it is difficult to determine whether a measured effect on jury decision making produces more substantively just results. *Id.* Much of the literature arguing that jurors are generally competent to interpret scientific expert testimony relies on this metric in some way—jurors are not systematically worse than judges. *See, e.g.*, Luke M. Froeb & Bruce H. Kobayashi, *Naive, Biased, Yet Bayesian: Can Juries Interpret Selectively Produced Evidence*, 12 J. L. ECON. & ORG. 257, 261–62 n.22 (1996). We should be skeptical of this metric for present purposes; while jurors may be *no worse* than judges, this leaves open the question whether either is adequately competent to satisfy the demands of intellectual due process. *See infra* notes 149–154 and accompanying text; *see also* Brewer, *supra* note 5, at 1539.

131. Nancy J. Brekke et al., *Of Juries and Court-Appointed Experts: The Impact of Nonadversarial Versus Adversarial Expert Testimony*, 15 L. & HUM. BEH. 451 (1991).

132. Vidmar & Diamond, *supra* note 126, at 1166–67; Myers, Reinstein & Griller, *supra* note 126, at 152 (citing studies finding "that jurors . . . take their fact-finding and decision-making responsibilities seriously").

133. *See, e.g.*, SANDERS, *supra* note 67, at 117–42 (recounting jurors' difficulty in understanding scientific evidence in toxic tort cases).

134. Daniel A. Krauss & Bruce D. Sales, *The Effects of Clinical and Scientific Expert Testimony on Juror Decision Making in Capital Sentencing*, 7 PSYCHOL. PUB. POL'Y & L. 267, 273 (2001) (citing articles); Richard C. Waites & David A. Giles, *Are Jurors Equipped to Decide the Outcome of Complex Cases*, 29 AM. J. TRIAL ADVOC. 19, 37–39 (2005); *cf.* Mnookin, *supra* note 26, at 1013 ("[T]he main mechanisms for assessing expertise outside of one's domain

ambiguous, finding that some jurors readily resort to heuristic modes of thinking to deal with complex testimony, while others attempt to engage in “central processing,” or what Kahneman and Tversky refer to as “System 2” processing, of such information.¹³⁵ The difference, however, is one of degree. “[A]ll jurors . . . regularly employ some forms of heuristic or mental shortcuts.”¹³⁶ Their tendency to do so is directly related to the complexity of the expert testimony at issue.¹³⁷ When jurors become “overtaken” by the complexity of the evidence, they “will eventually resort to a set of simple principles that have successfully guided them for most of their lives.”¹³⁸ Other studies confirm that such heuristics are unreliable proxies for genuine expertise.¹³⁹

of knowledge are, by necessity, secondary indicia, proxies: demeanor, perhaps, or credentials, or superficial explanatory plausibility.”).

135. See Vidmar & Diamond, *supra* note 126, at 1138, 1140–49 (citing studies); see generally DANIEL KAHNEMAN, THINKING, FAST AND SLOW (2011).

136. Waites & Giles, *supra* note 134, at 38.

137. Krauss & Sales, *supra* note 134, at 274 (citing articles); see also Joel Cooper & Isaac M. Neuhaus, *The “Hired Gun” Effect: Assessing the Effect of Pay, Frequency of Testifying, and Credentials on the Perception of Expert Testimony*, 24 L. & HUM. BEH. 149 (2000) (finding that complexity of evidence increases juror reliance on heuristic devices); Joel Cooper, Elizabeth A. Bennett & Holly L. Sukel, *Complex Scientific Testimony: How Do Jurors Make Decisions?*, 20 L. & HUM. BEH. 379 (1996) (stating that highly complex evidence caused mock jurors to form beliefs on the basis of contending experts’ credentials). Vidmar and Diamond point out that these studies ignore the fact that jurors are instructed to consider such heuristics as expert credentials in weighing experts’ testimony. Vidmar & Diamond, *supra* note 126, at 1174. Moreover, Brewer points out that credentials are rational proxies for reliable expertise where the underdetermination condition is not met. See Brewer, *supra* note 5, at 1630–34.

138. Waites & Giles, *supra* note 134, at 39.

139. See Vidmar & Diamond, *supra* note 126, at 1129 n.26 (citing studies); cf. Mnookin, *supra* note 26, at 1013 (“[T]he power of proxy criteria, like demeanor or credentials, to discriminate between reliable and unreliable experts is likely to be quite limited indeed.”); but see Froeb & Kobayashi, *supra* note 130, at 270–71 (using a formal model of jury decision making to conclude that “competitively produced evidence in an adversarial setting may mitigate some of the costs attributed to decision-maker bias and to the use of simplified rules or heuristics to evaluate selectively produced information”). More generally, studies indicate that demeanor is a poor indicium of credibility and that jurors often struggle to distinguish truthful statements from falsehoods. ALDERT VRIJ, DETECTING LIES AND DECEIT: PITFALLS AND OPPORTUNITIES (2011); Max Minzner, *Detecting Lies Using Demeanor, Bias, and Context*, 29 CARDOZO L. REV. 2557 (2007).

Jurors' ability to understand probabilistic and statistical evidence also has been the subject of mixed empirical reviews.¹⁴⁰ Many studies find that jurors tend to under-emphasize statistical evidence relative to the weight that an ideal Bayesian analysis would ascribe it.¹⁴¹ Saks and Kidd explain that this is due in part to an overemphasis on case-specific information, such as, for example, the perceived credibility of a narrative witness, as compared to statistical base-rate information.¹⁴² Jurors also show difficulty understanding and applying econometric evidence.¹⁴³ On the other hand, Thompson adds that, in cases involving forensic identification, jurors may over-value the evidence where the error rate of the forensic method is high and the defendant "was selected in a manner that renders him more likely to possess the matching characteristics than the general population."¹⁴⁴ Moreover, many (though not all) mock jurors tend to be susceptible to statistical fallacies such as the "Prosecutor's Fallacy," which equates the likelihood of guilt with the inverse of the probability of a random match if the defendant were innocent,¹⁴⁵ or the "Defense

140. See William C. Thompson, *Are Juries Competent to Evaluate Statistical Evidence?*, 52 L. & CONTEMP. PROBS. 9, 41 (1989) (finding "no single or simple answer" to the question of whether jurors are competent to evaluate statistical evidence).

141. E.g., David H. Kaye et al., *Statistics in the Jury Box: How Jurors Respond to Mitochondrial DNA Match Probabilities*, 4 J. EMPIRICAL LEGAL STUD. 797, 801 (2007); Jason Schklar & Shari Seidman Diamond, *Juror Reactions to DNA Evidence: Errors and Expectancies*, 23 L. & HUM. BEH. 159, 178, 180 (1999); Brian C. Smith et al., *Jurors' Use of Probabilistic Evidence*, 20 L. & HUM. BEH. 49, 79-80 (1996) (adding that, while jurors do under-weigh statistical evidence, they also make use of such evidence in their decision making processes and are sensitive to variations in its quality); Jonathan J. Koehler, Audrey Chia & Samuel Lindsey, *The Random Match Probability in DNA Evidence: Irrelevant And Prejudicial?*, 35 JURIMETRICS 201 (1995); Gary L. Wells, *Naked Statistical Evidence of Liability: Is Subjective Probability Enough?*, 62 J. PERSONALITY & SOC. PSYCHOL. 739 (1992); Thompson, *supra* note 140, at 41; Michael J. Saks & Robert F. Kidd, *Human Information Processing and Adjudication: Trial by Heuristics*, 15 L. & SOC. REV. 123, 149, 155-56 (1980); cf. Krauss & Sales, *supra* note 134, at 300 (finding that mock jurors weighed clinical opinion testimony more highly than actuarial evidence).

142. Saks & Kidd, *supra* note 141, at 150-51.

143. Richard A. Posner, *The Law and Economics of the Economic Expert Witness*, 13 J. ECON. PERSP. 91, 96 (1999); Daniel L. Rubinfeld, *Econometrics in the Courtroom*, 85 COLUM. L. REV. 1048 (1985).

144. Thompson, *supra* note 140, at 41.

145. As Kaye et al. explain:

Consider a case in which the expert testifies that the [random-match probability] is 1 percent (meaning that there is only a 1 percent chance that the DNA from a randomly

Attorney's Fallacy," which deems associative evidence irrelevant because it shows, at most, that the defendant is a member of some large group.¹⁴⁶ Although jurors are capable of avoiding reasoning fallacies in familiar situations, they are unable to transfer reasoning skills to formally identical, unfamiliar situations.¹⁴⁷

The empirical literature also casts substantial doubt on the effectiveness of the traditional tools of the adversarial model, such as the presentation of countervailing evidence or limiting instructions, in mitigating jurors' cognitive fallibilities. Levett and Kovera find that the presentation of a defense expert pointing out flaws in the prosecution expert's methodology, regardless of the quality of the defense expert's testimony, renders jurors more skeptical of expert testimony overall and more likely to return a guilty verdict.¹⁴⁸ Nor are limiting instructions sufficient to prevent jurors from drawing forbidden inferences where otherwise

selected, unrelated person in the relevant general population would match the DNA profile in the crimescene sample). The fallacy consists of concluding that because there is only a 1 percent chance that an innocent person would match, the chance that the defendant is innocent is 1 percent and, hence, that there is a 99 percent chance that the defendant is guilty. This transposes the conditional probability that a man would match given that he is innocent, $P(M|I)$, into the conditional probability that the defendant is innocent given that he matches, $P(I|M)$.

Kaye et al., *supra* note 141, at 803.

146. William C. Thompson & Edward L. Schumann, *Interpretation of Statistical Evidence in Criminal Trials: The Prosecutor's Fallacy and the Defense Attorney's Fallacy*, 11 L. & HUM. BEH. 167 (1987); cf. Hans, *supra* note 124, at 37 (finding that jurors are significantly more prone than judges to the Defense Attorney's Fallacy).

147. Vidmar & Diamond, *supra* note 126, at 1136 (citing Harold Kelly, *The Process of Causal Attribution*, 28 AM. PSYCHOL. 107 (1973)); cf. David L. Faigman & A.J. Baglioni, Jr., *Bayes' Theorem in the Trial Process: Instructing Jurors on the Value of Statistical Evidence*, 12 L. & HUM. BEH. 1 (1988).

148. Lora M. Levett & Margaret Bull Kovera, *The Effectiveness of Opposing Expert Witnesses for Educating Jurors about Unreliable Expert Evidence*, 32 L. & HUM. BEH. 363, 370–71 (2008). In a subsequent study, Levett and Kovera found "limited evidence for a sensitivity effect [i.e., prospective jurors being 'sensitized' to variations in the scientific validity of the plaintiff expert's testimony via critical testimony of an opposing expert] and strong evidence for a skepticism effect of opposing expert testimony." Lora M. Levett & Margaret Bull Kovera, *Psychological Mediators of the Effects of Opposing Expert Testimony on Juror Decisions*, 15 PSYCHOL. PUB. POL'Y & L. 124, 143 (2009). They "find little evidence that opposing experts will directly affect case outcomes; the safeguard seems to make jurors more skeptical of all expert testimony." *Id.*

inadmissible evidence is introduced pursuant to Rule 703 to “assist” the jury with understanding the basis of an expert’s opinion. The premise that limiting instructions are generally ineffective or, worse, produce a “backlash effect” whereby jurors’ attention is focused directly on the forbidden inference, is well established in the empirical literature.¹⁴⁹ There is no reason to believe that limiting instructions are more effective at mitigating the prejudicial effects of otherwise inadmissible evidence introduced pursuant to Rule 703 than they are in any other context.

Finally, despite courts’ frequent assumption that judges are more effective at interpreting complex scientific evidence than juries,¹⁵⁰ the available evidence indicates that this is largely untrue. Judges and juries show high rates of agreement in outcomes, rates that are unaffected by the complexity of the evidence.¹⁵¹ Both groups sometimes perform well at basic comprehension tasks. Hans’s comparative study of judges’ and jurors’ ability to comprehend scientific testimony regarding mitochondrial DNA, for example, found that “both judges and jurors performed reasonably well, scoring between eight and nine questions correct [on a comprehension test] on average.”¹⁵² However, judges as a group are generally as susceptible to fallacious reasoning and reliance on heuristics in the face of complex testimony, as are jurors.¹⁵³ Like jurors, they also struggle to interpret probabilistic and statistical evidence.¹⁵⁴ Judges, too, are generally incapable of disregarding evidence admitted for a particular purpose, or deemed inadmissible, from their holistic decision-making

149. See Nancy Steblay et al., *The Impact on Juror Verdicts of Judicial Instruction to Disregard Inadmissible Evidence: A Meta-Analysis*, 30 L. & HUM. BEH. 469, 486 (2006) (concluding from a meta-analysis of 48 studies that inadmissible evidence to which jurors are exposed can affect verdicts, and that limiting instructions are ineffective at countering that effect).

150. See *infra* notes 165–166 and accompanying text.

151. See Waites & Giles, *supra* note 134, at 23–25 (citing studies).

152. Hans, *supra* note 124, at 38.

153. Chris Guthrie et al., *Inside the Judicial Mind*, 27 CORNELL L. REV. 777 (2000); Wells, *supra* note 141, at 744–45; Hans, *supra* note 124, at 36–40 (finding that judges and mock jurors generally performed similarly on comprehension tests, with statistically significant differences on only three of 11 questions; of those three, judges were significantly more likely to be correct on two, and jurors were significantly more likely to be correct on one).

154. Wells, *supra* note 141; see Vidmar & Diamond, *supra* note 126, at 1170 (citing THE EVOLVING ROLE OF STATISTICAL ASSESSMENTS AS EVIDENCE IN THE COURTS (Stephen E. Fienberg ed., 1989)).

process.¹⁵⁵ For the most part, there is little reason to believe that judges acting as factfinders would process expert information better, or reach substantively different outcomes, than would juries.

D. Prior Reform Proposals

A necessarily brief survey of the century-long conversation about epistemic competence illustrates the intractability of the problem. The causes are easy to diagnose: judges and jurors lack the specialist knowledge necessary to make sense of expert evidence or to distinguish genuine expertise from pseudo-expertise or charlatantry. These problems are exacerbated by the adversarial process, which drives experts, consciously or otherwise, to bias their opinions in favor of their employer and incentivizes attorneys to “shop” not for the most knowledgeable expert, but for the most charismatic person willing to testify in support of their side. So much has been obvious to commentators from Hand and Wigmore in the early 20th century¹⁵⁶ to Faigman and Mnookin in the 21st.¹⁵⁷ During the same period, a number of reforms have been proposed to mitigate the problem.¹⁵⁸ This section will briefly survey the history of proposals to improve courts’ performance in evaluating scientific expertise and explain why the efforts thus far have been less than completely successful.¹⁵⁹

The most popular proposal has been to reintroduce non-partisan experts into the litigation process, either as a replacement

155. Andrew J. Wistrich et al., *Can Judges Ignore Inadmissible Information? The Difficulty of Deliberately Disregarding*, 153 U. PENN. L. REV. 1251 (2005); Guthrie et al., *supra* note 153.

156. John H. Wigmore, *To Abolish Partisanship of Expert Witnesses, as Illustrated in the Loeb-Leopold Case*, 15 J. AM. INST. CRIM. L. & CRIMINOLOGY 341 (1924); Hand, *supra* note 24.

157. David L. Faigman, *Anecdotal Forensics, Phrenology, and Other Abject Lessons from the History of Science*, 59 HASTINGS L.J. 979, 983–84 (2008); Mnookin, *supra* note 26.

158. Judicial gatekeeping itself, of course, counts as the foremost of these measures. Because gatekeeping has been discussed extensively in Section II.B above, it is excluded from the discussion of reform proposals in this section.

159. A few scholars have rejected the view that courts lack epistemic competence to perform the tasks required of them. *See, e.g.*, Waites & Giles, *supra* note 134, at 58–63 (suggesting “storytelling” innovations to convey information to jurors more effectively); Bruce Abramson, *Blue Smoke or Science - The Challenge of Assessing Expertise Offered as Advocacy*, 22 WHITTIER L. REV. 723, 766–67 (2001) (arguing that “radical reform is unnecessary” and the *Daubert* approach “requires nothing beyond the competence of any of the trial’s participants”).

for partisan expert witnesses,¹⁶⁰ as non-testifying technical advisors to the judge,¹⁶¹ or in some other capacity. A number of commentators, including Justice Breyer in *Joiner*, have encouraged courts to make greater use of their authority to appoint experts;¹⁶² others have called for a variety of systems whereby the parties jointly select non-partisan experts in lieu of partisan ones.¹⁶³

Other proposals have looked to institutional or doctrinal changes to increase courts' ability to effectively incorporate expert knowledge into the legal decision-making process. Sanders, for example, recommends the bifurcated trial process adopted by some courts in Bendectin mass tort cases, in which the issue of general causation is tried separately and prior to other issues involving liability and damages.¹⁶⁴ Myers et al. encourage widespread adoption of Arizona's reforms to its jury system, which permit juries to "ask questions, take notes, and in civil cases allow[] jurors to discuss the evidence during the trial."¹⁶⁵ Some courts have recognized or spoken favorably in dicta about the "complexity" exception to the Seventh Amendment's right to jury trial, whereby civil cases may be tried by a judge rather than a jury where the case is "too complex for a jury to understand and

160. Learned Hand, for example, called for "a board of experts or a single expert, not called by either side, who shall advise the jury of the general propositions applicable to the case which lie within his province." Hand, *supra* note 24, at 56; see also ALVIN I. GOLDMAN, KNOWLEDGE IN A SOCIAL WORLD 309-10 (1999).

161. *E.g.*, Jan Beyea & Daniel Berger, *Scientific Misconceptions Among Daubert Gatekeepers: The Need for Reform of Expert Review Procedures Complex Litigation at the Millennium*, 64 L. & CONTEMP. PROBS. 327, 365-66 (2001).

162. *Gen. Elec. Co. v. Joiner*, 522 U.S. 136, 148 (Breyer, J., concurring); see David L. Faigman & John Monahan, *Psychological Evidence at the Dawn of the Law's Scientific Age*, 56 ANN. REV. PSYCHOL. 631, 654-55 (2005); Sofia Adrogué & Alan Ratliff, *The Independent Expert Evolution: From the Path of Least Resistance to the Road Less Traveled*, 34 TEX. TECH L. REV. 843, 895-97 (2002); Laural L. Hooper, Joe S. Cecil & Thomas E. Willging, *Assessing Causation in Breast Implant Litigation: The Role of Science Panels Causation in Law and Science*, 64 L. & CONTEMP. PROBS. 139, 181-84 (2001); Gottesman, *supra* note 33, at 776-77; Joe S. Cecil & Thomas E. Willging, *Accepting Daubert's Invitation: Defining a Role for Court-Appointed Experts*, 43 EMORY L. J. 995 (1994); Berger, *supra* note 46; Samuel R. Gross, *Expert Evidence*, 1991 WIS. L. REV. 1113, 1211-30 (1991); Beyea & Berger, *supra* note 161, at 365; Wigmore, *supra* note 156, at 342.

163. *E.g.*, Posner, *supra* note 143, at 96; Rubinfeld, *supra* note 143, at 1096; Mason Ladd, *Expert Testimony*, 5 VAND. L. REV. 414, 430-31 (1952).

164. SANDERS, *supra* note 67, at 203-06.

165. Myers, Reinstein & Griller, *supra* note 126, at 152.

decide rationally.”¹⁶⁶ The Supreme Court itself appeared to endorse at least that general approach, noting that the question whether a claim is a “legal” (as opposed to equitable) one to which the jury trial right applies is to be determined in part by “the practical abilities and limitations of juries.”¹⁶⁷ Doctrinal reforms advocated by scholars include Faigman et al.’s recent proposal, drawing on earlier work by Monahan and Walker,¹⁶⁸ that the gatekeeping doctrine should draw a distinction between general scientific facts that apply across cases and should therefore be found by the judge, and diagnostic facts relevant only to the specific case, which should be left to the jury.¹⁶⁹

Reformers have also called for institutional reforms to place subject-matter experts in the role of legal factfinders, whether by bringing back some version of specialized juries¹⁷⁰ or creating specialized courts to adjudicate cases in technical areas of law.¹⁷¹

166. *In re Japanese Elec. Prods. Antitrust Litig.*, 631 F.2d 1069, 1090 (3d Cir. 1980); see Brewer, *supra* note 5, at 1672–77; Joseph A. Miron, *The Constitutionality of a Complexity Exception to the Seventh Amendment*, 73 CHI.-KENT L. REV. 865, 896 (1998) (arguing that a complexity exception would be “a constitutional exercise of the courts’ power under the Seventh Amendment”); James S. Campbell, *The Current Understanding of the Seventh Amendment: Jury Trials in Modern Complex Litigation*, 66 WASH. U. L.Q. 63, 70 (1988) (“The reality is that nothing in the seventh amendment prevents judges from striking jury demands in complex and protracted civil litigation.”); *but cf.* Waites & Giles, *supra* note 134, at 26–28 (arguing against complexity exception). Contrary to Waites and Giles’s suggestion that the complexity exception “eliminate[s] jury decisions on issues that juries have been deciding for centuries,” the exception has historical roots. *Id.* at 25–26. Golan notes that “[b]y 1875, Common Law judges were officially granted unfettered discretion in civil actions to order a trial without a jury in any matter requiring scientific evidence that, in their opinion, could not be handled by the credulous jury.” GOLAN, *supra* note 25, at 88.

167. *Ross v. Bernhard*, 396 U.S. 531, 538 (1970).

168. Monahan & Walker, *supra* note 97.

169. David L. Faigman et al., *Gatekeeping Science: Using the Structure of Scientific Research to Distinguish between Admissibility and Weight in Expert Testimony*, 110 NW. U. L. REV. 859, 890–99 (2016) (citing articles).

170. See Beyea & Berger, *supra* note 161, at 365–66; Mnookin, *supra* note 26, at 1028 n.49 (citing proposals). On the historical roots of specialized juries, see Mnookin, *supra* note 5, at 767–68; GOLAN, *supra* note 24, at 19; Hand, *supra* note 24, at 40–43.

171. The proposed “science court,” which received much attention in the 1970s, was intended to improve courts’ ability to integrate scientific expertise into judicial decision-making. See JASANOFF, *supra* note 48, at 65–66; Arthur Kantrowitz, *The Science Court Experiment: Criticisms and Responses*, 33 BULL. ATOMIC SCI. 44 (1977); Arthur Kantrowitz, *Proposal for an Institution for Scientific Judgment*, 156 SCI. 763 (1967). More recent scholarship continues to propose variations on the science court idea. See, e.g., Justin Sevier, *Redesigning*

The highly technical area of patent law has seen both doctrinal and institutional design innovations intended to enhance the epistemic competence of the tribunal. In *Markman v. Westview Instruments, Inc.*,¹⁷² the Supreme Court held that technical questions of patent construction are to be decided by the judge in a pre-trial hearing. Justice Souter's opinion noted that the jury's "capabilities to evaluate demeanor, to sense the mainsprings of human conduct, or to reflect community standards . . . are much less significant than a trained ability to evaluate the testimony in relation to the overall structure of the patent."¹⁷³ Similarly, Congress has long provided for specialized appellate review of patent decisions. Since 1982, all appeals of district court decisions in patent cases have been heard by the Federal Circuit Court of Appeals¹⁷⁴ and, prior to that year, were heard by the U.S. Court of Customs and Patent Appeals.¹⁷⁵

the Science Court, 73 MD. L. REV. 770 (2013); Rai, *supra* note 79. For a more recent proposal, see Andrew W. Jurs, *Science Court: Past Proposals, Current Considerations, and a Suggested Structure*, 15 VA. J. LAW TECH. 1–42 (2010).

On the simpler end of the spectrum, some institutional reforms would attempt to improve judges' competence through training programs in math and science. See, e.g., Billauer, *supra* note 28, at 43, 56–57.

172. 517 U.S. 370 (1996).

173. *Id.* at 389–90 (internal quotation marks omitted). Some scholars, however, are skeptical of generalist judges' ability to interpret patent claims. See, e.g., Peter Lee, *Patent Law and the Two Cultures*, 120 YALE L.J. 2, 6 (2010) ("[N]o matter how eloquently policymakers craft patent law, if generalist judges lack the capacity to administer it, the patent system cannot fulfill its objectives."); cf. David L. Schwartz, *Practice Makes Perfect? An Empirical Study of Claim Construction Reversal Rates in Patent Cases*, 107 MICH. L. REV. 223, 248–49 (2008) (finding 32% reversal rate of lower court claim constructions between 1996–2007); Kimberly A. Moore, *Markman Eight Years Later: Is Claim Construction More Predictable*, 9 LEWIS & CLARK L. REV. 231, 233 (2005) (finding a 34.5% reversal rate of appealed claim constructions from 1996–2003); Kimberly A. Moore, *Are District Court Judges Equipped to Resolve Patent Cases*, 15 HARV. J. L. TECH. 1, 2–3 (2001) (noting that 33% rate of reversal of construction claim appeals between 1996–2000).

174. 28 U.S.C. § 1295(a)(4) (2018).

175. Federal Courts Improvement Act of 1982, Pub. L. 97–164 §165, 96 Stat. 50 (1982); see generally GILES RICH, A BRIEF HISTORY OF THE UNITED STATES COURT OF CUSTOMS AND PATENT APPEALS (1980). Some have questioned whether lay jurors should be involved in the adjudication of patent claims at all. See, e.g., Mark A. Lemley, *Why Do Juries Decide If Patents Are Valid*, 99 VA. L. REV. 1673, 1674–77 (2013) (summarizing arguments); Jennifer F. Miller, *Should Juries Hear Complex Patent Cases?*, 2004 DUKE L. & TECH. REV. 4 (2004); Michael A. Fisher, *Going for the Blue Ribbon: The Legality of Expert Juries in Patent Litigation*, 2 COLUM. SCI. & TECH. L. REV. 1 (2001); Miron, *supra* note 166.

Some scholars have argued for the creation of a specialized trial court for patent cases.¹⁷⁶

A third group of proposals has aimed at diminishing partisan experts' incentives to bias their testimony. Some commentators suggest that every expert witness's testimony should be made formally available to that expert's professional community, whether by publication in a professional journal, online publication, or a system of peer review.¹⁷⁷ Others suggest that American courts should consider the Australian practice of "hot tubbing," whereby partisan experts produce a joint report noting areas of agreement and disagreement.¹⁷⁸

The proposals surveyed above, to the extent they have been implemented, have met with varying degrees of success, but none has solved the perennial problem of epistemic competence. Non-partisan experts, in some form, are almost surely more effective at conveying scientific information to lay legal decision makers because their testimony is not biased by partisan incentives. But as Brewer explains, "extra-cameral" solutions involving the transfer of expertise from neutral experts to non-expert decision makers "do not resolve the problems or explain how the nonexpert practical reasoner can handle selection and competition in a nonarbitrary manner."¹⁷⁹ Specialized courts, such as the Federal Circuit, have received positive reviews of their ability to handle technical material, but they are an insufficient solution to a general problem.¹⁸⁰ Not only have specialized courts been criticized as uniquely susceptible to "capture," prone to "hide their biases behind impenetrable specialized jargon," and out of touch with legal developments occurring in generalist courts,¹⁸¹ the problem of epistemic competence is simply too ubiquitous to be solved by the creation of specialized courts. It is not logistically possible to create a specialized institution for every area in which specialized

176. E.g., Jay P. Kesan & Gwendolyn G. Ball, *Judicial Experience and the Efficiency and Accuracy of Patent Adjudication: An Empirical Analysis of the Case for a Specialized Patent Trial Court*, 24 HARV. J. L. & TECH. 393 (2010).

177. Posner, *supra* note 143, at 98; Gross, *supra* note 162, at 1211–30.

178. Gary Edmond & Joëlle Vuille, *Comparing the Use of Forensic Science Evidence in Australia, Switzerland, and The United States: Transcending the Adversarial-Nonadversarial Dichotomy*, 54 JURIMETRICS 221 (2014); Megan A. Yarnall, *Dueling Scientific Experts: Is Australia's Hot Tub Method a Viable Solution for the American Judiciary?*, 88 OREGON L. REV. 311 (2009).

179. Brewer, *supra* note 5, at 1615; *see id.* at 1614, 1681.

180. *See, e.g.*, Rochelle Cooper Dreyfuss, *The Federal Circuit: A Case Study in Specialized Courts*, 64 N.Y.U. L. REV. 1, 24–25 (1989).

181. *Id.* at 3.

testimony is used; a *general* solution is imperative.¹⁸² Moves to shift technical questions from jury to judge are particularly unhelpful, as there is no reason to think that a non-expert judge is any better than a non-expert jury at interpreting scientific testimony.¹⁸³ Likewise, existing programs such as judicial training and the Reference Manual of Scientific Expertise are manifestly inadequate to instill the expertise necessary to engage with scientific evidence in a non-arbitrary way; indeed, they may even be counterproductive insofar as they instill in judges a false sense of epistemic competence.¹⁸⁴ A full solution to the problem has yet to be found; as we will see in the next Part, it will require a shift in epistemological frame through which the problem has thus far been conceptualized.

IV. DESIGNING COMPETENT COURTS

The previous Part described the theoretical and empirical contours of the problem of epistemic competence and surveyed many of the proposals that have been put forth over the past century to facilitate courts' engagement with scientific expertise. None of those solutions has fully solved the problem because each adheres to the individualist epistemological paradigm that has dominated the conversation thus far. Thanks to the convergence of theoretical and empirical studies, we now know the form that a solution must take: the legal decision maker must also possess expertise in the relevant scientific domain. But that solution appears to demand the impossible: judges and jurors who possess substantive expertise in the multitude of scientific domains with which a generalist court must interact. Human minds are limited

182. See Kesan & Ball, *supra* note 176, at 402 ("Boundary problems make it difficult to determine which court should preside over the case and may force the judiciary of a specialized court to deal with areas of the law beyond its expertise.").

183. See *supra* notes 150–154 and accompanying text.

184. This is a psychological phenomenon known as the "Dunning-Kruger effect." See Justin Kruger & David Dunning, *Unskilled and Unaware of It: How Difficulties in Recognizing One's Own Incompetence Lead to Inflated Self-Assessments*, 77 J. PERSONALITY & SOC. PSYCHOL. 1121 (1999). As Dunning explains, "[a] whole battery of studies . . . have confirmed that people who don't know much about a given set of cognitive, technical, or social skills tend to grossly overestimate their prowess and performance, whether it's grammar, emotional intelligence, logical reasoning, firearm care and safety, debating, or financial knowledge." David Dunning, *We Are All Confident Idiots*, PAC. STANDARD (Oct. 27, 2014), <https://psmag.com/we-are-all-confident-idiots-56a60eb7febc#.g5bjlsmhs>.

and the acquisition of expertise is costly; how can the insights of classical epistemology and the sociology of scientific knowledge be directed toward a practical solution to the problem of epistemic competence? The answer, this Part will argue, comes from the field of social epistemology: we must extract ourselves from the epistemological paradigm that has dominated the conversation for the past century to reconceive of the *court*, rather than individual judicial officers, as the epistemic agent of interest. This Part will describe a solution to the problem of epistemic competence that reforms the epistemic system of the court to possess both legal authority and scientific expertise.

A. *The Failure of Brewer's Two Hat Solution*

As discussed above,¹⁸⁵ Brewer proposes a “two hat” solution in which legal authority and scientific expertise are held by the same individual. Brewer’s two hat approach solves the epistemological problem but suffers from implementation challenges that are obscured by a lack of descriptive detail. He suggests that the two hat model could be implemented by creating “administrative agencies staffed with trained scientists, scientific expert magistrate judges, or even special science courts staffed by scientifically trained judges” without acknowledging the institutional and logistical challenges in those proposals.¹⁸⁶ How many individuals with expertise in both law and a given scientific domain exist, and how many of those are ready, willing, and otherwise qualified to accept positions as trial court judges? Consider also the number of scientific domains with which a generalist court must interact in the course of its work; the two hat solution would require a single judge to possess expertise in *all* of those domains. Brewer’s two hats quickly become a multitude of hats—a veritable epistemic millinery—and the call for overlapping expertise reduces to a lamentation of the lack of human omniscience. Valid, so far as it goes, but not particularly helpful as a practical solution.

Brewer falls into what this Article will call the *atomization trap*. He remains committed to an epistemological paradigm that

185. *Supra* Section III.B.1.

186. Brewer, *supra* note 5, at 1677. Administrative agencies and magistrate judges, as we will see below, work as solutions only when they are incorporated within a system of distributed cognition in which the substantive expert plays an equal or near-equal role in the decision-making process as the trial judge. See *infra* Section IV.B.2. Otherwise these solutions are of the extra-cameral type that Brewer recognized as insufficient. Brewer, *supra* note 6, at 1614–15, 1681 n.445.

conceives only of individual human minds as epistemic agents.¹⁸⁷ That focus is understandable; the problem of epistemic competence does indeed arise from the limitations of isolated human minds. In an ideal world, judges and jurors would possess all of the knowledge necessary to engage with the substance of all scientific expert testimony that came before the court, in which case the problem would not arise. But courts operate in a non-ideal world, in which the acquisition of knowledge is costly and no single mind is capable of possessing the full sum of human knowledge. The atomization trap is the root cause of intractability in the century-long discussion of epistemic competence: because the participants in that discussion could conceive only of individual minds as epistemic agents, they were unable to identify a means of incorporating scientific expertise into legal decision making in an epistemically valid way. The problem could only be mitigated, never solved. In order to find a full solution, we must escape the atomization trap.

B. Social Epistemological Approaches: Escaping the Atomization Trap

1. Institutions and Collective Knowledge

Two relatively recent developments in social epistemology offer a way out of the atomization trap. The first focuses on the epistemological status of what Goldman refers to as *collective doxastic agents*,¹⁸⁸ i.e., the properties of groups as epistemic agents.¹⁸⁹ This includes the nature of the relationship between the

187. See Brewer, *supra* note 5, at 1608–14 (addressing the “collectivist” epistemology of John Hardwig, who articulates a theory of “epistemic dependence” to account for the fact that nearly all knowledge ultimately depends on deference to the claims of others concerning facts that we could not, or will not, independently verify. John Hardwig, *Epistemic Dependence*, 82 J. PHIL. 335 (1985)). But Hardwig’s “collectivist” account does not conceive of groups as epistemic agents; rather, he attempts to account for justification of knowledge claims of the form “*B* knows that *A* knows that *p*, therefore *B* knows that *p*.” John Hardwig, *Epistemic Dependence*, 82 J. PHIL. 340 (1985).

188. ALVIN I. GOLDMAN, *A Guide to Social Epistemology*, in RELIABILISM AND CONTEMPORARY EPISTEMOLOGY 226 (Alvin I. Goldman ed., 2012). While Goldman prefers the term “doxastic” agents, this Article will continue to use “epistemic” to retain emphasis on collective *knowledge* over belief. See Kay Mathiesen, *The Epistemic Features of Group Belief*, 2 EPISTEME 161, 161 (2006) (“For the purposes of epistemology the key question is whether groups can be knowers.”).

189. See generally Philip Pettit, *Groups with Minds of Their Own*, in SOCIAL EPISTEMOLOGY: ESSENTIAL READINGS 242 (Alvin I. Goldman ed., 2010)

knowledge of the group and the knowledge of its constituent members, as to which several contending views exist. *Summativists* posit a direct relationship: the knowledge of the group is the knowledge of all or most of its members.¹⁹⁰ A summativist account of group knowledge is superficially appealing, but on closer examination is both under- and over-inclusive. Frederick Schmitt gives an example of the latter situation, drawing on Margaret Gilbert's thought experiment positing two committees, a Library Committee and a Food Committee, with identical membership.¹⁹¹ The members of the Library Committee know that the library contains one million volumes; the Library Committee therefore also knows that fact. But does the Food Committee know it? By a summativist account, it must: the constituents of the two committees are identical. But some intuitively reject that account; the purview of the Food Committee does not include library books, and therefore the Food Committee cannot claim knowledge on that subject.¹⁹² As Gilbert explains, "according to our intuitive conceptions it is not logically sufficient for a group belief that *p* either that most group members believe that *p*, or that there be common knowledge within the group that most members believe that *p*."¹⁹³ An alternative model better captures the dynamics of the court as a collective epistemic agent.

Bird describes a *distributivist* model of group knowledge in which no individual constituent possesses all of the knowledge ascribed to the group.¹⁹⁴ The "key feature" of that model is

(describing collectively reasoning groups as "intentional subjects" and "institutional persons").

190. See, e.g., Margaret Gilbert, *Modelling Collective Belief*, 73 SYNTHESE 185, 186 (1987); Anthony Quinton, *Social Objects*, 76 PROC. ARISTOTELIAN SOC'Y 1 (1975). Strands of methodological individualism that insist that the mental states of groups are reducible to those of constituent members are essentially summativist. See, e.g., Kenneth A. Schepsle, *Congress is a "They," Not an "It": Legislative Intent as an Oxymoron*, 12 INT'L REV. L. & ECON. 239 (1992).

191. Frederick F. Schmitt, *The Justification of Group Beliefs*, in SOCIALIZING EPISTEMOLOGY: THE SOCIAL DIMENSIONS OF KNOWLEDGE 261 (Frederick F. Schmitt ed., 1994) (citing MARGARET GILBERT, ON SOCIAL FACTS 273 (1989)).

192. *Id.*

193. MARGARET GILBERT, ON SOCIAL FACTS 273 (1989); see also Mathiesen, *supra* note 188, at 162. ("[I]t is neither necessary nor sufficient for the members [of a group] to believe *p* in order for the group to believe that *p*.").

194. Alexander Bird, *When Is There a Group That Knows? Distributed Cognition, Scientific Knowledge, and the Social Epistemic Subject*, in ESSAYS IN COLLECTIVE EPISTEMOLOGY 44–45 (Jennifer Lackey ed., 2015).

distributed cognition: “the [cognitive] task is broken down into components, which are given to different members of the group. Membership of the group . . . is a matter of having a particular function within the overall system.”¹⁹⁵ Unlike, say, the Library Committee in which each member performs the same epistemic task and all possess the same knowledge, members of a distributed cognition group are nodes in a collective *epistemic system*,¹⁹⁶ each of which makes a unique contribution to the generation of group knowledge. This connects the second relevant development: *systems-oriented* social epistemology, which “examine[s] the systems [*sic*] in question to see whether its mode of operation is genuinely conducive to the specified epistemic ends,” and “would also identify alternative organizational structures that might be epistemically superior to the existing systems.”¹⁹⁷ Bird suggests “the wider enterprise of science” as a model of distributed cognition, but science is not the only system that this description fits.¹⁹⁸

The institutional structure of the common law court is one that can be conceived as a system of distributed cognition. Figures 1 and 2 show schematics of the common law epistemic systems at the pretrial and trial stages.

195. *Id.* at 45. Bird cites Hutchins’s sociological study of the navigation process of a large ship as an example of distributed cognition. See EDWIN HUTCHINS, *COGNITION IN THE WILD* 175–77 (1995). In that system, “[s]everal crew members are given different landmarks whose bearings they are required to record and to communicate to a plotter who determines the ship’s position and course.” Bird, *supra* note 194, at 45. No single individual has direct access to all of the knowledge necessary to plot the ship’s position.

196. Goldman defines epistemic systems as “social systems [that] are to be studied in terms of their effects on epistemic outcomes.” GOLDMAN, *supra* note 188, at 228.

197. *Id.* at 228–29.

198. Bird, *supra* note 194, at 48–51.

FIGURE 1: EPISTEMIC SYSTEM OF PRETRIAL DECISION MAKING

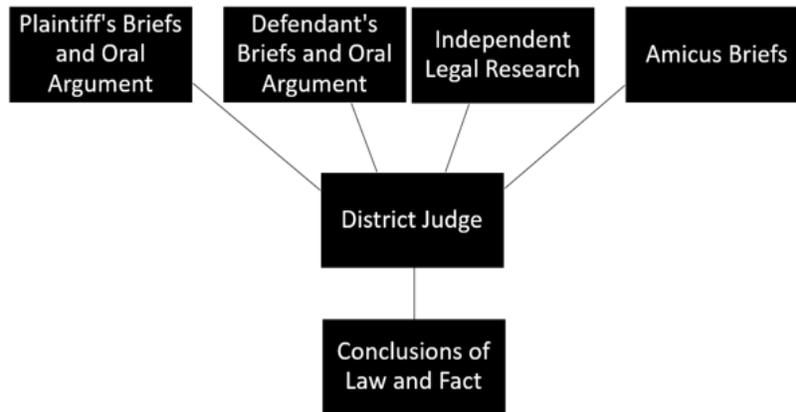


Figure 1 illustrates the pretrial system, in which all of the relevant inputs feed into the district court judge. The judge alone considers the parties' briefs, her own (and her clerks') independent research, and, in rare cases, any amicus briefs filed in the case, and then, drawing on her own legal expertise, produces a set of legal and, where appropriate, factual conclusions.¹⁹⁹ Figure 1 omits certain complications—for example, magistrate judges may resolve non-dispositive motions or issue “reports and recommendations” on dispositive motions, but their actions are subject to review by the district judge.²⁰⁰ Likewise, the court may refer cases or issues to special masters for resolution, but only in “exceptional” circumstances and generally more readily for the calculation of damages than at the liability stage.²⁰¹ Moreover, none of these

199. Judges do not “find facts” at the pretrial stage, but they *do* reach factual conclusions, for example, by assuming the truth of the facts as stated in the complaint, see, for example, *Ashcroft v. Iqbal*, 556 U.S. 662, 679 (2009) (“When there are well-pleaded factual allegations, a court should assume their veracity and then determine whether they plausibly give rise to an entitlement to relief.”), or by determining which facts are “material” and “undisputed” for purposes of summary judgment, see FED. R. CIV. P. 56. Judges also determine facts as necessary to resolve motions in limine, discovery disputes, and other pretrial matters.

200. See FED. R. CIV. P. 72.

201. FED. R. CIV. P. 53; see *La Buy v. Howes Leather Co.*, 352 U.S. 249, 256–257 (1957) (vacating district judge’s *sua sponte* referral of cases to special master for trial); *Prudential Ins. Co. v. U.S. Gypsum Co.*, 991 F.2d 1080, 1086 (3d Cir. 1993) (“A district court has no discretion to delegate its adjudicatory responsibility in favor of a decision maker who has not been appointed by the President and confirmed by the Senate.”); *Stauble v. Warrob*, 977 F.2d 690, 691 (1st Cir. 1992) (“[R]eferring fundamental issues of liability to a master for adjudication, over objection, is impermissible”); see also Section IV.B.3, *infra* (discussing Article III limitations on delegation of decision-making authority to scientific adjuncts). The 2003 amendments to Rule 53 of the Federal Rules of

ancillary officers can act in the absence of a grant of authority from the district court judge, who retains effective control over pretrial decision making.

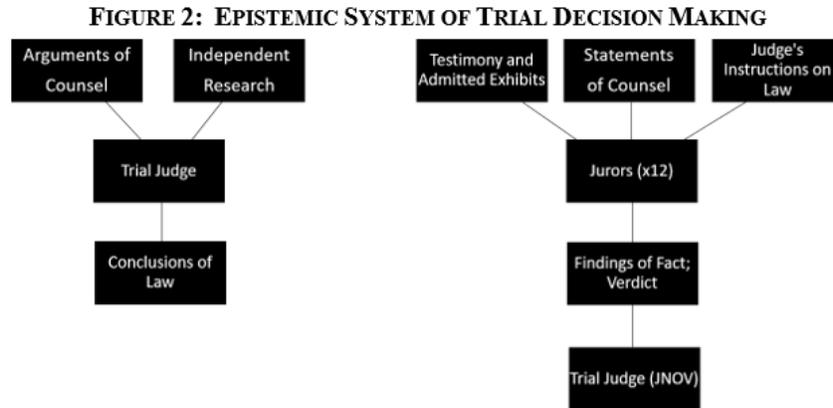


Figure 2 illustrates the distinct epistemic paths of decision making in a jury trial. Questions of law concerning the admissibility and sufficiency of evidence, the content of the jury instructions, and other legal matters are made by the trial judge on the basis of the parties' objections, motions, and (occasionally) briefs as well as the judge's independent research, while questions of fact, including at least the general verdict and at times specific findings in a special verdict, are made by the jurors on the basis of the testimony and exhibits introduced at trial, the arguments of counsel, and the judge's legal instructions. Once again, the trial judge has full authority over all questions of law. The jury is responsible for finding facts and rendering a verdict; this does involve collective epistemic action, but each juror still acts essentially as an individual epistemic agent.²⁰² Finally, the trial judge retains authority to enter judgment as a matter of law either after the close of a party's case or after the jury has returned a verdict if "a reasonable jury would not have a legally sufficient evidentiary basis to find for the party on that issue."²⁰³

Civil Procedure expanded the scope of courts' discretion to appoint special masters beyond that contemplated by *La Buy*, but it remains the case that, absent the consent of the parties, special masters can be appointed only in "exceptional" circumstances or "to perform an accounting or resolve a difficult computation of damages." FED. R. CIV. P. 53(1)(B); see *Glover v. Wells Fargo Home Mortg.*, 629 F. App'x 331, 338 (3d Cir. 2015).

202. Unlike the ship's crew in Hutchins's study of navigation, individual jurors are not epistemically differentiated; each is given the same informational input and the same epistemic task. See HUTCHINS, *supra* note 195, at 175–85.

203. FED. R. CIV. P. 50(a)(1).

Goldman describes the F.B.I.'s failure to "connect the dots" between the knowledge its field agents had about 9/11 hijackers' flight training and the agency's control group in Washington, D.C. as "a gargantuan failure, a social-epistemic failure."²⁰⁴ The courts' failure, in countless cases across more than a century, to apply competently scientific expertise to the resolution of legal disputes is likewise a "gargantuan" social-epistemic failure, and one that inflicts untold costs on litigants and the public interest. The cause in both cases is the same: the failure of an epistemic system inadequate to the task for which the institution applied it. The judicial process is one of distributed cognition within the institutional epistemic agent of the court, whereby constituent members contribute to *institutional* knowledge. So conceived, it is clear that the epistemic systems currently in place fail to produce valid results as applied to scientific expert testimony. But this shift in perspective creates an opportunity to escape the atomization trap that has impeded scholarly discussions for over a century. A focus on the *court*, rather than the judge or jurors in isolation, enables us to consider other modes of distributed cognition that may more effectively achieve the goals of intellectual due process.

2. Courts as Epistemic Agents: The Social Epistemological Solution

By reconceiving courts as institutional epistemic agents possessing internal systems of distributed cognition, we can avoid the atomization trap and apply the insights of classical epistemology and the sociology of scientific knowledge to solve the problem of epistemic competence. The *social epistemological solution* (SES) applies the social epistemological perspective to incorporate scientific expertise into courts' epistemic systems. The result is a collective epistemic agent that possesses both substantive expertise and legal authority, implementing the two hat model and satisfying the demands of intellectual due process.

Described at that level of generality, the SES could be implemented in countless ways, many of which would require drastic departures from existing institutional structures.²⁰⁵ For

204. Alvin I. Goldman, *Group Knowledge Versus Group Rationality: Two Approaches to Social Epistemology*, 1 *EPISTEME* 11, 18 (2004).

205. For example, some scholars have proposed that the United States abandon the common-law adversarial system in favor of something akin to the inquisitorial system. See, e.g., Sevier, *supra* note 171, at 794–95. It may be the case that the inquisitorial system is epistemically superior to existing adversarial practices, but it is unlikely to be adopted in the foreseeable future.

reasons of political viability as well as to preserve the values embedded in the institutional structure of the common law court, this Article attempts here to describe a method of enacting the SES that maintains as much of the Anglo-American adversarial model as possible while implementing an epistemologically valid solution to the problem of epistemic competence. It proposes the creation of a new division of the Administrative Office of the U.S. Courts, the Office of Scientific Adjuncts (OSA), staffed by individuals with at least “interactional” expertise in all of the major scientific domains that routinely come before the courts.²⁰⁶ The rules of evidence and procedure would be amended in two ways: first, to require parties to serve notice on the *court* of the identity of their expert witnesses within the same time frame set by the rules of civil and criminal procedure for party disclosures,²⁰⁷ and second, to provide that at least one scientific adjunct with expertise in each relevant scientific domain would be assigned to every case. The involvement of scientific adjuncts would be automatic and non-discretionary, and the assignment of scientific adjuncts—including the determination of what substantive expertise is needed—would be made within the OSA by a manager possessing “referred” expertise.²⁰⁸ Thus, the “hats” of scientific expertise would be readily available in every case, as the OSA would have authority to retain additional experts on an *ad hoc* basis in cases involving atypical scientific domains in which no permanent staff had expertise.

The incorporation of scientific adjuncts must balance two competing concerns. The first is scientific expertise itself. The adjunct must have sufficient influence over the outcome of science-relevant decisions that her expertise may be attributed to the court as an institutional epistemic agent; she cannot be, in Brewer’s parlance, an extra-cameral advisor.²⁰⁹ At the same time, the process of legal decision making requires *legal* as well as scientific

206. Collins and Evans define interactional expertise as specialist expertise sufficient to engage in conversation on equal terms with other experts, but not to make new contributions to the discipline. COLLINS & EVANS, *supra* note 11, at 14, 28–31. In practice, while keeping in mind the lessons against overreliance on credentials as an exclusive proxy for expertise noted in note 21, above, possession of a Master of Science or equivalent degree in the relevant field should suffice as a reasonably reliable signifier of interactional expertise.

207. See FED. R. CIV. P. 26(a)(2); FED. R. CRIM. P. 16(a)(1)(G).

208. COLLINS & EVANS, *supra* note 11, at 15, 65–66 (defining referred expertise as “the use of expertise learned in one domain in another domain,” as by a manager of an interdisciplinary scientific project).

209. See *supra* note 179 and accompanying text.

expertise.²¹⁰ The legal expertise of the trial judge, who understands the rules of evidence, the nature of the case, and the “fit” between the scientific evidence and the legal claims,²¹¹ is as essential to the competent resolution of legal questions involving the application or interpretation of scientific fact as is scientific expertise. Thus, we must adopt an epistemic system that brings both forms of expertise to bear on the resolution of these questions, while also respecting the prerogatives of the jury as the ultimate finder of facts. The SES does so as follows. At the pretrial stage, scientific adjuncts would decide the issues of expert qualification and gatekeeping, subject to review for clear error by the trial judge. The parties’ *de facto* veto over review of expert qualifications and methods would be eliminated. Scientific adjuncts would review expert witnesses’ qualifications in all cases, and they would have broad authority to engage in *sua sponte* gatekeeping. Scientific adjuncts would also be given input into the scientific aspects of motions for summary judgment. Figures 3A-3C illustrate the modified epistemic system of the pretrial SES.

FIGURE 3A: PRETRIAL SES IN CASES NOT INVOLVING SCIENTIFIC EXPERT EVIDENCE

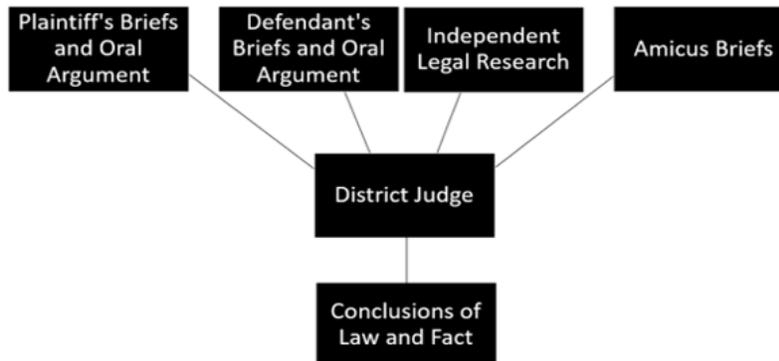


Figure 3A shows the implementation of the SES in cases not involving scientific expertise. It is identical to Figure 1 in that the trial judge serves as the sole authority of law and fact (again omitting such ancillary officers as magistrate judges and law clerks). Where scientific expertise is involved, however, the SES would implement a different epistemic system, as Figures 3B and 3C illustrate.

210. The author does not believe it necessary or practical to require that scientific adjuncts hold law degrees. On-the-job training in the legal procedures and doctrines relevant to their relatively narrow role should suffice.

211. See *Daubert v. Merrell Dow Pharms.*, 509 U.S. 579, 592 (1993).

FIGURE 3B: PRETRIAL SES IN EXPERT QUALIFICATION AND GATEKEEPING

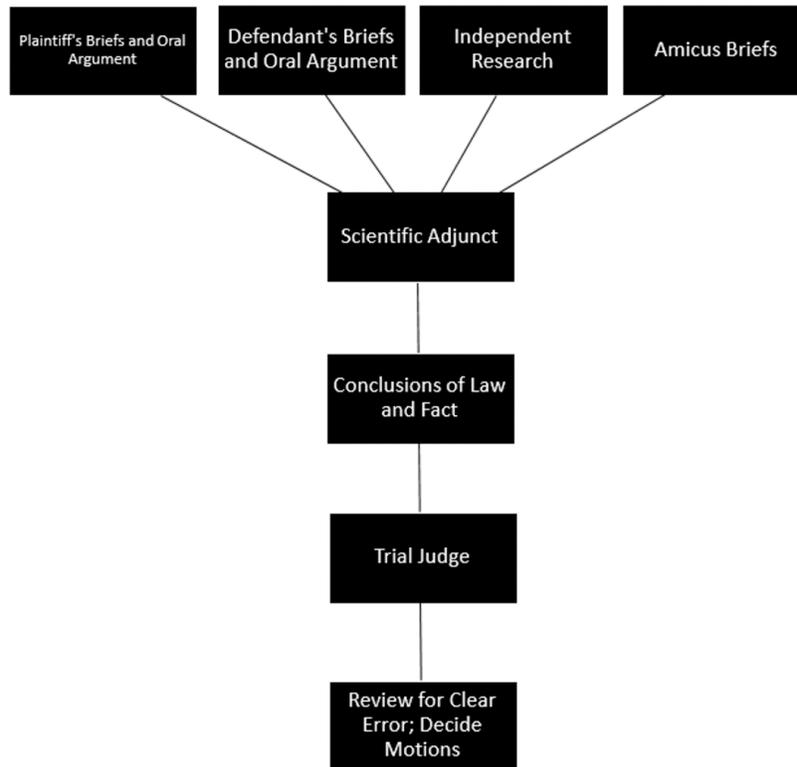


Figure 3B illustrates the epistemic system that the SES would implement for pretrial expert qualification and gatekeeping motions. All of the epistemic inputs in these motions would first pass to the scientific adjunct rather than the trial judge. This includes the parties' briefs, oral arguments, and, in the rare cases in which they are filed, amicus briefs.²¹² Scientific adjuncts would have authority to conduct independent research and to base their decisions, as appropriate, on the results of such review. The trial judge would review that decision for clear error and either ratify or, where necessary, reverse the scientific adjunct's decision.

In the context of summary judgment motions, the technical expertise held by scientific adjuncts and the legal expertise held by trial judges are even more intertwined. Figures 3C-1 and 3C-2 illustrate the epistemic system that the SES would implement in summary judgment motions.

212. Hearings on gatekeeping and expert witness qualification would require cooperation between the scientific adjunct and the trial judge. Hearings would be conducted by the trial judge. Scientific adjuncts would attend the hearings and have the opportunity to pose questions to counsel.

FIGURE 3C-1: PRETRIAL SES IN SUMMARY JUDGMENT MOTIONS (1)

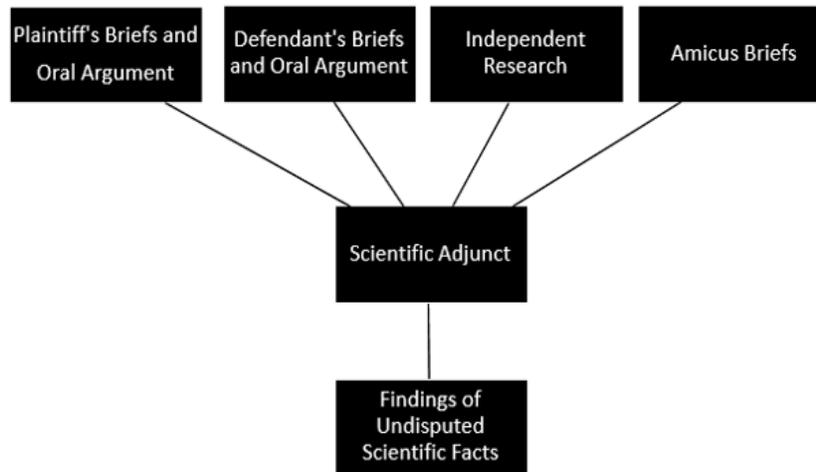
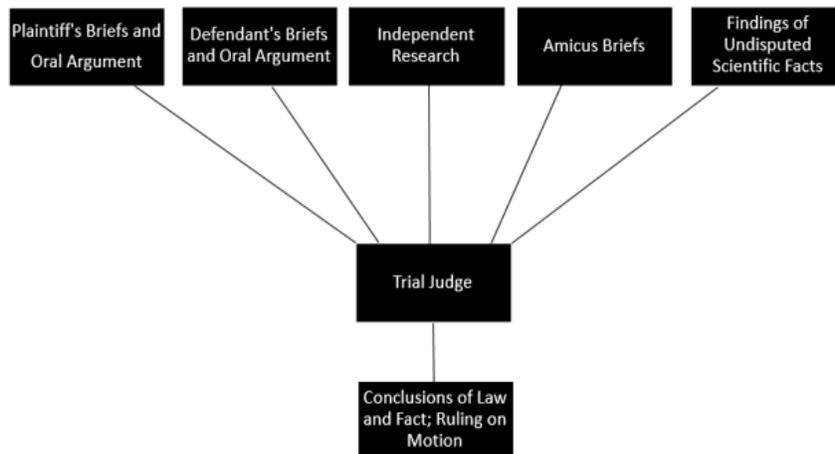


FIGURE 3C-2: PRETRIAL SES IN SUMMARY JUDGMENT MOTIONS (2)

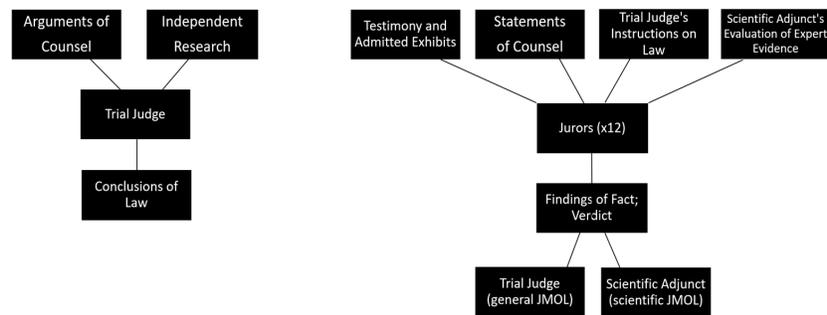


As illustrated in Figure 3C-1, the scientific adjunct's role in summary judgment motions would be limited to determining whether scientific facts are material and disputed. The adjunct would make that decision on the basis of the parties' briefs, independent scientific research, and, where available, amicus briefs. If the scientific adjunct determines that genuine issues of material scientific fact preclude summary judgment, then the trial judge should deny the motion; otherwise, as illustrated in Figure 3C-2, the judge must consider the legal issues surrounding the motion in light of the undisputed scientific facts as the scientific adjunct found them.

The SES would also utilize scientific adjuncts' expertise at trial. Judges would make legal rulings on trial motions as under the

existing system.²¹³ Parties would continue to present partisan experts,²¹⁴ and factfinding authority would remain vested in the jury, but the scientific adjunct(s) assigned to the case would be required to present, subject to examination by both parties, their opinion of both experts' testimony, including opinions on the ultimate scientific facts. They would also have authority to overturn juries' verdicts as contrary to scientific fact, a "scientific judgment as a matter of law" analogous to district courts' authority under Federal Rules of Civil Procedure 50(a) and (b). Figure 4 illustrates the system of distributed cognition that the SES would implement at trial.

FIGURE 4: TRIAL SES



In short, the scientific adjuncts would be directly responsible for deciding the legal issues in the case pertaining to scientific evidence and for providing a neutral opinion to the factfinder as to how the partisan experts' testimony should be weighed. The result is a multi-node epistemic system in which every decision is made

213. Because motions involving qualification and gatekeeping would be resolved at the pretrial stage, scientific adjuncts should not need to be involved in resolving trial motions. When parties move to recognize experts as qualified at trial, such motions could be granted by the trial judge on a *pro forma* basis where the scientific adjunct has determined the expert to be qualified in pretrial proceedings.

214. Partly this is to maintain fidelity to the adversarial model, and partly because research has shown that adversarial presentation of expert testimony results in greater jury engagement with the content of the testimony than does the testimony of court-appointed experts alone. Brekke et al., *supra* note 131, at 469–70. Moreover, maintaining the jury as the ultimate finder of fact preserves what Froeb and Kobayashi refer to as the “Hayekian” advantages of imperfect decentralized decision makers. Froeb & Kobayashi, *supra* note 130, at 259. At the same time, reforms to the epistemic system of jury deliberations, perhaps of the sort recommended by Myers et al., are compatible with the SES and could be adopted as supplemental measures to further improve the courts' capacity to engage with scientific evidence. See Myers et al., *supra* note 126, at 153–56.

by an individual with expertise in the appropriate domain—the domain of law for the legal matters decided by the judge, and the relevant scientific domain for scientific questions decided by scientific adjuncts.

To be sure, this brief sketch of the SES leaves many details unresolved. How many scientific adjuncts should be assigned to a case? What restrictions, if any, on *ex parte* communications between the scientific adjunct and the trial judge should exist? How will the court distinguish between *scientific* questions, where the involvement of scientific adjuncts would be required, and “other technical” matters, in which it would not be? This Article takes no position on which of the conceivable permutations of the SES is the optimal one; that decision involves budgetary, logistical, and political factors beyond the scope of our epistemological focus. So long as the essential criteria outlined above are satisfied, the problem of epistemic competence is solved. However, some objections to this system are obvious. The next section will discuss a few of the most salient objections or critiques of the SES.

3. Critiques and Objections

The sketch of the SES above is somewhat sparse with respect to only a single feature: the incorporation of scientific expertise into the epistemic system of the court. This Article will nevertheless address a few objections that might be raised against it. The list of objections below is by no means exhaustive, and responses to them are necessarily brief. They are intended both to acknowledge the tradeoffs implicit in the SES and also to argue that the SES is constitutionally and normatively viable.

a. Is the SES Constitutional?

The SES involves the reallocation of decision making authority from the trial judge to a judicial officer—the scientific adjunct—who does not enjoy Article III status.²¹⁵ The constitutional limit of delegation to non-Article III decision makers is a complex area of law, and a full analysis of the SES’s constitutional prospects would require a lengthier inquiry than space permits here. This section will make the case that most of the authority that the SES would allocate to scientific adjuncts can be plausibly analogized to tasks already performed by other non-Article III decision makers and that the allocation is justifiable when “assessed by reference to the

215. U.S. CONST. art. III, § 1.

purposes underlying the requirements of Article III.”²¹⁶ To the extent the SES requires some expansion of existing precedent, it is justified by demonstrated necessity, the control that Article III judges and jurors continue to have over most dispositive issues, and by the fact that the SES would not represent a congressional effort to “emasculat[e]” the federal courts,²¹⁷ but rather an effort to improve the quality and legitimacy of their decision-making process.

Several types of non-Article III officials already participate in the adjudicative process. Special masters,²¹⁸ magistrate judges,²¹⁹ bankruptcy judges,²²⁰ and administrative agencies²²¹ all exercise authority to resolve disputes cognizable in Article III courts. The constitutional evaluation of non-Article III decision making turns on two interests: the personal interest in having claims resolved by an Article III adjudicator and the structural interest of “barring congressional attempts ‘to transfer jurisdiction for the purpose of emasculating’ constitutional courts and thereby prevent[ing] ‘the encroachment or aggrandizement of one branch at the expense of the other.’”²²²

Mandatory involvement of scientific adjuncts obviously implicates parties’ personal interest in an Article III adjudicator. While the personal interest is often satisfied by the consent of the parties to an alternative adjudicator,²²³ consent cannot solve the problem here because the SES cannot rely on parties’ voluntary cooperation. A consent requirement would allow parties relying on

216. *Commodity Futures Trading Comm’n v. Schor*, 478 U.S. 833, 847 (1986).

217. See *Wellness Int’l Network, Ltd. v. Sharif*, 135 S. Ct. 1932, 1944 (2015).

218. See FED. R. CIV. P. 53; see also *Milik v. Sec. of Health & Hum. Serv.*, 822 F.3d 1367 (Fed. Cir. 2016); *H.L. ex rel. A.I. v. Sec. of Health & Hum. Serv.*, 129 Fed. Cl. 165 (2016).

219. See 28 U.S.C. § 636 (2018); *United States v. Raddatz*, 447 U.S. 667 (1980).

220. 28 U.S.C. § 157 (2018); cf. *Wellness Int’l*, 135 S. Ct. at 1938; *Stern v. Marshall*, 564 U.S. 462, 484 (2011); *N. Pipeline Constr. Co. v. Marathon Pipe Line Co.*, 458 U.S. 50, 84 (1982).

221. See, e.g., *Schor*, 478 U.S. at 850–51.

222. *Wellness Int’l*, 135 S. Ct. at 1944 (quoting *Schor*, 478 U.S. at 850).

223. See *Wellness Int’l*, 135 S. Ct. at 1947; *Schor*, 478 U.S. at 855; cf. *Stern*, 564 U.S. at 493; *Northern Pipeline*, 458 U.S. at 79 n.31 (plurality opinion), 91 (Rehnquist, J., concurring in the judgment); compare *Gomez v. United States*, 490 U.S. 858, 875–76 (1989) (holding that Article III was violated where magistrate judge supervised voir dire in felony trial without defendant’s consent) with *Peretz v. United States*, 501 U.S. 923, 932, 936–37 (1991) (holding that Article III was not violated where defendant consented to magistrate judge’s supervision of felony voir dire).

weak scientific evidence to veto a more competent gatekeeper in favor of a less competent one. On the other hand, the consent of the parties is unnecessary for the adjudication by magistrate judges of non-dispositive pretrial motions, as trial judges may refer such motions without consent of the parties for decision by magistrate judges subject to review for clear error.²²⁴ Expert qualification and gatekeeping are non-dispositive motions, and while motions for summary judgment are dispositive in principle, scientific adjuncts could not directly dispose of a case; they could only direct that such a motion be *denied*.²²⁵ At the trial stage, scientific adjuncts' testimony is analogous to the testimony already permitted by a court-appointed expert under Rule 706. The authority of the scientific adjunct to enter a scientific judgment as a matter of law (JMOL) is potentially dispositive, but the use of such authority would presumably be rare, and this abridgement of the personal right to adjudication by an Article III judge is plausibly justified by the improvement in reliability and rationality of decisions.

Turning to the structural interest, a principal factor in legitimizing the delegation of authority to non-Article III actors has been the discretionary reference and oversight of the ancillary decision maker.²²⁶ Here, too, the SES is something of a departure from that norm. Involvement of scientific adjuncts would be non-discretionary, and assignment of adjuncts would be handled by the OSA rather than the trial judge. This arrangement is necessary to preserve the integrity of the SES's epistemic system. Experience with Rule 706 and state court equivalents has shown that judges rarely exercise their discretion to appoint neutral experts.²²⁷ If the

224. 28 U.S.C. § 636(b)(1)(A) (2018); FED. R. CIV. P. 72(a); see *Raddatz*, 447 U.S. at 673.

225. Scientific adjuncts could not directly *grant* a motion for summary judgment; in the event that the scientific adjunct determines that all material issues of scientific fact are undisputed, the trial judge would consider those scientific facts alongside the non-scientific facts and applicable legal doctrines in deciding the motion.

226. See *Wellness Int'l*, 135 S. Ct. at 1944; *Peretz*, 501 U.S. at 937; cf. *Schor*, 478 U.S. at 855 (noting that Article III structural interests would prevent Congress from “creat[ing] a phalanx of non-Article III tribunals equipped to handle the entire business of the Article III courts without any Article III supervision or control,” but permits delegation of jurisdiction over common law counterclaims to agency adjudicator where “the decision to invoke this forum is left entirely to the parties and the power of the federal judiciary to take jurisdiction of these matters is unaffected”).

227. See Stephanie Domitrovich, Mara L. Merlino & James T. Richardson, *State Trial Judge Use of Court Appointed Experts: Survey Results And Comparisons*, 50 JURIMETRICS J. 371, 382 (2010) (finding that 6.9% of sample

SES is to be effective, it cannot rely on judicial discretion for implementation. However, the trial judge does retain substantial control over case-dispositive decisions under the SES. As noted above, most of the scientific adjunct's work—deciding expert qualification and gatekeeping motions, determining the undisputed scientific facts in summary judgment motions, and offering opinion testimony at trial—is non-dispositive. The standard of review for non-dispositive motions is the same under the Federal Magistrate Act and the SES;²²⁸ in both cases, the trial judge defers to the magistrate judge's or scientific adjunct's decision unless it is clearly erroneous or contrary to law (as, for example, might be the case if the scientific adjunct misapplies the *Daubert* standard). The trial judge's authority over dispositive motions, including the decision to grant a motion for summary judgment, is disturbed only insofar as the scientific adjunct would have authority to enter a scientific JMOL. Finally, the scientific adjunct's decisions in all areas would remain subject to appellate review by Article III judges under the same standard of review as a decision made by the trial judge.²²⁹

We must also consider the SES's purpose and its relationship between Article III and subsequent amendments, specifically the Fifth Amendment's Due Process Clause. The SES is not an attempt to “emasculat[e]” the federal courts, but rather to facilitate their mission to deliver substantive justice and procedural due process.²³⁰ If we take seriously the concept of intellectual due process,²³¹ then Article III's limitations on the reallocation of judicial power must be interpreted to comport with the demands imposed on the judicial process by subsequent amendments. If, as the epistemological and sociological analyses surveyed above have

cases in which a proffer of expert testimony was made ($n = 11,639$ involved the discretionary appointment of a court-appointed expert); FEDERAL JUDICIAL CENTER, COURT-APPOINTED EXPERTS: DEFINING THE ROLE OF EXPERTS APPOINTED UNDER FEDERAL RULE OF EVIDENCE 706 (1989); Tahirih V. Lee, *Court-Appointed Experts And Judicial Reluctance: A Proposal to Amend Rule 706 of the Federal Rules Of Evidence*, 6 YALE L. & POL'Y REV. 480 (1988).

228. See 28 U.S.C. § 636(b)(1)(A) (2018).

229. Cf. *H.L. ex rel A.I. v. Secretary of Health and Human Services*, 129 Fed. Cl. 165, 176 (2016) (holding that adjudication by special master and Article I court does not deprive petitioners of right to Article III adjudicator where “Petitioners may appeal this decision to the United States Court of Appeals for the Federal Circuit”).

230. *Wellness Int'l*, 135 S. Ct. at 1944. Measures should undoubtedly be taken in the appointment of scientific adjuncts to insure their independence and insulation from political influence. These details are indisputably important to the effective functioning of the SES, but I leave them for later consideration.

231. See *infra* Section IV.B.3.b.

demonstrated,²³² the existing system is incapable of interpreting and applying scientific expert testimony in a manner that satisfies intellectual due process, then Article III might be deemed amended by the Due Process Clause to the extent necessary to implement an epistemic system capable of doing so.²³³

To be sure, the SES does not fit perfectly into existing precedents permitting delegation to ancillary officers. Nevertheless, much of the scientific adjuncts' authority would be comparable to that of the non-Article III decision makers recognized as constitutional under existing law. To the extent that the SES relies less on the consent of the parties or the discretion of the trial judge, it does so for the purpose of vindicating weighty due process concerns, not for the purpose of undermining the independence of Article III courts. The Article III objections to the SES are not frivolous, and a full constitutional defense would involve a lengthier analysis than is possible here, but plausible arguments exist for extending existing precedents to permit the epistemic system contemplated by the SES.

b. Is the SES Too Costly?

Would the addition of a new group of highly educated, and concomitantly highly paid, scientific professionals to the judicial process impose a substantial cost on an already financially strained judicial system? Yes, it would.²³⁴ How, in these times of stretched budgets and overburdened taxpayers, can we entertain the idea of imposing a new financial burden onto the court system?

The short answer is that due process may demand it. Brewer does not offer a lengthy doctrinal analysis in support of an argument that the Fifth or Fourteenth Amendments contain an intellectual due process component. A full analysis is beyond the scope of this Article as well, but here are some brief observations

232. See *supra* Section III.B.

233. Cf. *Seminole Tribe of Fla. v. Florida*, 517 U.S. 44, 65–66 (1996); *Fitzpatrick v. Bitzer*, 427 U.S. 445, 454 (1976).

234. Without denying that the SES would likely result in a net increase in costs of operating the court system, we should consider the mitigating effects that a more effective system would produce. Improving the epistemic competence of judicial decision making by incorporating expertise into judicial institutions would increase predictability of outcomes, allowing parties to negotiate “in the shadow of the law” with greater confidence, thus avoiding at least some lawsuits that would be filed under the current system. See Robert H. Mnookin & Lewis Kornhauser, *Bargaining in the Shadow of the Law: The Case of Divorce*, 88 YALE L.J. 950 (1979).

in support of the premise that epistemic competence is a necessary component of procedural due process. The leading case on procedural due process is *Mathews v. Eldridge*,²³⁵ in which the Court

emphasized that three factors should be considered in determining whether the flexible concepts of due process have been satisfied: (a) the private interests implicated; (b) the risk of an erroneous determination by reason of the process accorded and the probable value of added procedural safeguards; and (c) the public interest and administrative burdens, including costs that the additional procedures would involve.²³⁶

While we lack specific information on the cost of the SES—which would partly depend on details of its implementation to which we are epistemologically indifferent—we can say that the first two factors weigh heavily in favor of the SES over the status quo. Thus, at least, the cost of the SES would need to be quite high to justify rejecting it under the *Mathews* test.²³⁷

235. 424 U.S. 319 (1976).

236. *United States v. Raddatz*, 447 U.S. 667, 677 (1980); see *Nelson v. Colorado*, 137 S. Ct. 1249, 1255 (2017) (reaffirming the centrality of the *Mathews* factors).

237. This is an unusual procedural due process issue in that it is the full process of Article III adjudication, rather than a streamlined administrative process, that is under constitutional scrutiny. The *Mathews* analysis has generally been applied in the latter circumstance, with full adversarial adjudication before a neutral judge having “long been considered the gold standard of due process.” *King v. Marion Cir. Ct.*, 868 F.3d 589, 593 (7th Cir. 2017) (citing *Marchant v. Pa. R.R.*, 153 U.S. 380, 387 (1894); *Mathews*, 424 U.S. at 323). But the Due Process Clause surely applies to the deprivation of interests at stake in federal litigation—liberty and property in criminal cases, money and other property in tort and contract cases, and so on. And Brewer’s discussion of intellectual due process challenges the general assumption that Article III adjudication necessarily satisfies the Fifth Amendment’s requirements in all cases. Brewer, *supra* note 5, at 1676–77. That conclusion is by no means established, either by Brewer’s article (which focuses on intellectual due process as a “rule of law norm” more than as a matter of constitutional doctrine) or in this one. *Id.* at 1676. An analysis of the intellectual due process as a constitutional requirement rather than a normative desideratum would require a much deeper engagement with constitutional doctrine than space permits here; the extent to which my reliance on the *Mathews* test is persuasive thus depends on the extent to which the reader finds the concept of intellectual due process as a constitutional norm intuitively plausible. But even if the reader rejects a reading of the Due Process Clause that includes intellectual due process, the substance of this discussion stands: because the existing adjudicatory process fails to rationally incorporate

The principal private interest at stake—shared by all parties to litigation—is the rational evaluation of scientific evidence. This is an interest that cuts across nearly all types of cases—the interest, in the criminal justice system, of the rational interpretation of forensic evidence;²³⁸ in toxic torts, of reliable assessment of general causation; in securities fraud, of rational evaluation of loss causation and damages, to name but a few. This is an interest of enormous importance, second perhaps only to courts’ most fundamental function of nonviolent dispute resolution. But parties desire more than a mere resolution from courts; only a certain *type* of resolution is acceptable. Thus, the process by which the court adjudicates legal disputes is of central importance to the legitimacy of case outcomes.²³⁹ If this were not so—if the *rationality* of a court’s adjudicatory process were not of essential importance—then courts could save resources simply by deciding each case by flipping a coin.

Indeed, the second prong of the *Mathews* test, the risk of “erroneous” determination under existing procedures,²⁴⁰ presupposes the parties’ valid interest in a rational adjudicatory process. The very concept of “error” implies both the existence of a correct answer and a normative commitment to finding it.²⁴¹ As discussed in Part III, the risk of an erroneous determination under existing procedures is quite high.²⁴² Brewer compares the status quo to a literal coin flip,²⁴³ and empirical studies demonstrate that courts’ current epistemic systems are inadequate to reliably

scientific expertise into legal factfinding, the benefits of the SES outweigh substantial implementation costs, whether constitutionally mandatory or not.

238. As applied to criminal procedure, the question of whether procedural due process requires an epistemically competent adjudicator would be evaluated under the standard set forth in *Medina v. California*, 505 U.S. 437 (1992), rather than the *Mathews* test. In *Medina*, the Court held that a state’s decision in matters of criminal procedure is “not subject to proscription under the Due Process Clause unless it offends some principle of justice so rooted in the traditions and conscience of our people as to be ranked as fundamental.” *Id.* at 445 (quoting *Patterson v. New York*, 432 U.S. 197, 202 (1977)). Space does not permit a lengthy application of the *Medina* test; however, the non-arbitrary evaluation of evidence is fundamental to any reasonable conception of justice. It is surely as “fundamental” as the presumption of innocence. *See Nelson*, 137 S. Ct. at 1256 n.9.

239. *See, e.g.*, TOM R. TYLER, *WHY PEOPLE OBEY THE LAW* (1990).

240. *Mathews*, 424 U.S. at 335; *cf. Nelson*, 137 S. Ct. at 1255.

241. *See, e.g.*, *In re Japanese Elec. Prods. Antitrust Litig.*, 631 F.2d 1069, 1084 (3d Cir. 1980) (“A jury that cannot understand the evidence and the legal rules to be applied provides no reliable safeguard against erroneous decisions.”).

242. *See supra* Section III.C; *cf.* Section IV.B.2.

243. Brewer, *supra* note 5, at 1670–71.

interpret and apply scientific expertise to the resolution of legal disputes.²⁴⁴ Thus, the second prong also weighs heavily in favor of recognizing the SES as a procedural due process requirement.

c. Do Neutral Experts Exist?

The SES would diminish the influence of partisan experts on the judicial interpretation of scientific evidence. While parties would still retain partisan experts and the ultimate determination of scientific facts would remain with the lay factfinder, the intended effect of scientific adjuncts' presentation of their opinion of the partisan experts' testimony would be to influence the factfinder's evaluation of the partisans' claims.

We must acknowledge, however, that reducing partisanship is not a panacea. As several commentators have noted, advocates of non-partisan experts often assume too much about the ability of "settled" science to provide determinate answers to factual questions of legal interest.²⁴⁵ Scientific knowledge is necessarily tentative and probabilistic under even the best conditions, and litigation rarely provides the best conditions. Litigation often raises questions at the edge of human knowledge and in a context far less suited to produce reliable knowledge than the process of peer review, publication, and criticism through which scientific consensus is constructed in the academic environment.²⁴⁶ It is thus unsurprising that ample room for reasonable disagreement exists around much scientific evidence prepared for litigation. Mnookin and Jasanoff voice legitimate concerns that a preoccupation with "non-partisan" expertise may result in concealing the range of legitimate disagreement around tentative research.²⁴⁷ Thus, proposals for reform must provide a space for the expression of genuine uncertainty; they must avoid fostering a false confidence around knowledge that is quite often tentative and provisional.

At the same time, Mnookin overstates her case when she suggests that "those who call for neutral experts . . . at least partly misunderstand the nature of scientific disputes."²⁴⁸ This is so, she

244. See *supra* Section III.C.

245. See Mnookin, *supra* note 26, at 1021–22, 1026; JASANOFF, *supra* note 48, at 211–15; GOLAN, *supra* note 24, at 3.

246. See GOLAN, *supra* note 24, at 51 ("When scientific expertise is produced in response to litigation, science's normal processes of validation can be bypassed or distorted.").

247. Mnookin, *supra* note 26, at 1021–22, 1026; JASANOFF, *supra* note 48, at 211–15.

248. Mnookin, *supra* note 26, at 1027.

claims, because “whenever there is a legitimate scientific disagreement at issue in a legal case, a neutral expert would either mask a legitimate dispute or else be unable to offer ‘those general truths, applicable to the issue, which they may treat as final and decisive,’ for which Learned Hand and others have long craved.”²⁴⁹ Mnookin’s critique conflates imprecision in scientific estimation arising from *bias* with that arising from *uncertainty*. Mnookin is correct that some measure of uncertainty—random error—surrounds all empirical inference. The inductive logic of scientific inquiry is necessarily probabilistic, and scientific knowledge is always subject in principle to revision or even outright rejection in light of additional evidence.²⁵⁰ But it is possible to acknowledge uncertainty while mitigating *bias*—systemic error—in the presentation of expert knowledge to the court.²⁵¹

While uncertainty is intrinsic to the logic of scientific empiricism,²⁵² bias is not. Uncertainty in empirical estimation can arise from any number of specific sources, but fundamentally it is a consequence of the finitude of human experience. Our empirical

249. *Id.* (quoting Hand, *supra* note 24, at 55).

250. Stephanie Tai, *Uncertainty about Uncertainty: The Impact of Judicial Decisions on Assessing Scientific Uncertainty*, 11 U. PA. J. CONST. L. 671, 676 (2009) (footnote omitted) (“[T]o some extent the very nature of science can be characterized as uncertain because scientific theories are either underdeterminative, or are never fully consistent with all the available evidence.”); see generally NATE SILVER, *THE SIGNAL AND THE NOISE: WHY SO MANY PREDICTIONS FAIL—BUT SOME DON’T* (2015) (discussing practical difficulties in statistical prediction); DAVID HUME, *AN ENQUIRY CONCERNING HUMAN UNDERSTANDING* (Peter Millican ed., 2008) (discussing intrinsically probabilistic nature of inductive reasoning); COLIN HOWSON & PETER URBACH, *SCIENTIFIC REASONING: THE BAYESIAN APPROACH* (3d ed. 2006) (articulating a Bayesian model of scientific reasoning); KUHN, *supra* note 83 (introducing the concept of the scientific paradigm and discussing the distinction between normal and revolutionary scientific periods); KARL POPPER, *THE LOGIC OF SCIENTIFIC DISCOVERY* (1959) (introducing the criterion of falsifiability as a demarcation of scientific methodology, partly as a solution to Hume’s problem of induction).

In quantitative empiricism, uncertainty is reflected in the “confidence interval,” the range of values within which some percentage (often 95%) of data sets will contain the population value. See JEFFREY M. WOOLDRIDGE, *INTRODUCTORY ECONOMETRICS* 138–40 (4th ed. 2009). The confidence interval is a quantitative formalization of the uncertainty inherent in all empirical inference.

251. DAVID FREEDMAN, ROBERT PISANI & ROGER PURVES, *STATISTICS* 103–04 (4th ed. 2007). That bias rather than uncertainty is the principal type of error with which the critics of partisanship are concerned is clear in the literature. See, e.g., GOLAN, *supra* note 24, at 81, 96, 108, 110–11, 136; Mnookin, *supra* note 5, at 772–75; Gross, *supra* note 162, at 1115; Hand, *supra* note 24, at 53.

252. See Saks & Faigman, *supra* note 66, at 158–59.

beliefs reflect our best judgments about the nature of reality given the evidence available to us. The whole of the universe can never be observed; our inferences are thus inevitably based upon a comparatively few sample observations projected onto the entirety.²⁵³ Bias, on the other hand, is a wholly contingent and in principle correctable source of error, and the biasing effect of partisanship is well understood. This is not to say that all experts consciously frame their scientific assessment to support the legal claim of their client—though that does happen²⁵⁴—but motivated reasoning and implicit bias are well-documented sources of biased reasoning, and there is little reason to think that expert witnesses are immune from those phenomena.²⁵⁵ Thus, the elimination of partisan *bias* would improve courts' capacity to interpret scientific evidence, notwithstanding the fact that the *uncertainty* intrinsic to inductive inquiry would persist.

V. CONCLUSION

This Article has surveyed the problem of epistemic competence in the somewhat dry terms of the literatures with which it has engaged, but the problem is neither dry nor academic. Criminal defendants are at risk of wrongful conviction and civil plaintiffs are at risk of uncompensated injury because our system of dispute resolution is not up to the task of evaluating scientific evidence in a reliable way. The full scope of that problem is impossible to quantify, but, given the prevalence of expert evidence across so many areas of litigation, there is every reason to believe that the costs are substantial. This failure is directly attributable to the court's epistemic system—that is, the institutional

253. Even in those rare instances in which all instances of a phenomenon are observed, we are *still* projecting onto the unknown insofar as we predict the occurrence of future events on the basis of presently observed regularities. This is the essence of Hume's "problem of induction." See *generally* HUME, *supra* note 250; POPPER, *supra* note 250.

254. See, e.g., FISHER, *supra* note 33, at 225. Moreover, the adversarial system encourages selection bias, permitting parties to present the testimony of a qualified expert who may represent a small minority of the scientific community. See Vidmar & Diamond, *supra* note 126, at 1133 n.37 (citing studies).

255. See *generally* Dan M. Kahan, *Ideology, Motivated Reasoning, and Cognitive Reflection*, 8 JUDGMENT & DECISION MAKING 407, 416 (2013) ("[T]he disposition to engage in conscious and effortful System 2 information processing . . . actually *magnifies* the impact of motivated reasoning."); Avani Mehta Sood, *Motivated Cognition in Legal Judgments: An Analytic Review*, 9 ANN. REV. L. & SOC. SCI. 307 (2013) (surveying literature on motivated reasoning in legal decision making).

design that places full authority over legal questions in the hands of a single, scientifically untrained judge, and authority over factfinding to a lay jury.

Recent developments in epistemology and the sociology of scientific knowledge converge on the same conclusion: competent judgments on matters pertaining to scientific expertise can be made only by those who possess substantive expertise in the scientific domain. Brewer took us this far, but his prescription, like that of a century of commentators before him, was constrained by an atomized epistemological paradigm that could conceive only of natural persons as epistemic agents. Brewer's "two hat" solution would effectively require generalist judges to possess substantive expertise in *every* scientific domain that comes before the court. Such a demand is impossible, and Brewer avoided it only through a combination of descriptive obscurity and reliance on solutions such as extra-cameral advisors that his own epistemological analysis recognized as inadequate.

A workable solution to the problem, and the chief contribution of this Article, lies in discarding the individualist epistemological paradigm for a collectivist one. The social epistemological perspective considers the *court*, not the individual judge or jurors, as the principal epistemic agent, and asks how scientific expertise might be incorporated into the judicial process at the level of institutional knowledge. Adopting that perspective, this Article describes a system of distributed cognition, the *Social Epistemological Solution*, that would divide legal authority on matters of scientific expertise between scientific experts and the trial judge. Much like the navigation of a ship, the SES would facilitate the competent application of scientific knowledge to the resolution of legal disputes by dividing the larger epistemic task into smaller pieces, each assigned to a judicial officer with the requisite expertise. The ultimate effect is that the individual scientific adjunct's expertise becomes *institutional* expertise.

We should, however, not confuse a workable solution for an easy one. Even attempting to preserve as much of the existing adversarial system as possible, the SES would require a substantial departure from existing norms, which vest ultimate authority over all legal decisions with the trial judge and factfinding authority with the jury. In addition to raising political and possibly constitutional challenges, we should carefully consider whether such a departure is ultimately desirable in light of the broader normative goals of the judicial system. At the same time, the existing process results in arbitrary and unpredictable decision making that calls into

question the legitimacy of the judicial system and imposes incalculable harm on litigants. Maintaining the status quo is not a viable option. If the institutional changes necessary to create institutions capable of evaluating scientific evidence in a rational way prove politically or logistically infeasible, then we must reevaluate the institutional mission of judicial institutions to better comport with their existing epistemic capacities.