Speaking Science to Law

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Abstract

We consult scientific expert witnesses in almost every field of law. Yet even in cases involving a strong scientific consensus, the powerful qualities of scientific knowledge are easily lost in translation. Moreover, even prominent scientists who are committed to providing accurate information to legal fact-finders may suffer reputational harm simply for participating in an adversarial process.

This article analyzes the connection between law and science through the expert witness from the perspectives of epistemology and cross-cultural communication, focusing on the distinct ways in which scientists and lawyers know, value, and express their knowledge. When a lawyer meets with a scientific expert witness, more confusion attends their interaction than either likely realizes. Linguistic translation is necessary—but not only translation of the substance of science into terms accessible to the legal fact-finder. An additional form of translation is essential, though the need for it may go unnoticed: that of homonyms—terms that are superficially identical in law and science (such as "fact," "uncertainty," and "proof") but which have deeply different meanings in their respective disciplines. Lawyers and scientists may be using the same words without realizing that they are talking past each other.

Cultural translation is also required: while their professional norms concerning fact-finding have some overlap, in other respects they contrast so sharply that professional behavior for the lawyer would constitute malpractice for the scientist. In their cultures of knowledge-production, the scientist is most closely analogous to the judge in that the professional identities of both are founded in their neutrality. However, when the scientific fact-finder's report is presented to the legal fact-finder through the work of the lawyer, the scientist can appear partisan—and even risks becoming partisan. For a scientist, the appearance of partisanship is an appearance of impropriety that can cause her debilitating professional harm, threatening her professional identity.

The purpose of this article is to better equip lawyers and judges to make proper interdisciplinary translations in the process of speaking science to law.

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I. INTRODUCTION

> *[W]e must recognize and accommodate the needs of science in the rule of law. The complexity of the interaction between law and science remains to be understood. As we enter this intellectual endeavor with greater urgency, the judge and the scientist must take strong steps to understand each other, the better to serve each other.*[1]

Expert witnesses speak science to law. When scientists testify in court, they speak from one language into another, one profession into another, one discipline into another, one culture into another. To inform the fact-finder effectively, and to treat the witness and the judicial process fairly, lawyers need to understand the legal and scientific significance of how expert witnesses speak science. Drawing from the perspectives of legal and scientific fact-finders, this paper examines the transmission of information from the scientific realm into the legal, exploring how scientists know, and how they must (and must not) express their knowledge to protect their professional integrity and identity. To work properly, this interdisciplinary communication requires epistemic translation and cross-cultural sensitivity.

A scientist testifying in court is subject to the normative expectations of two politically powerful institutions: law and science. The expert witness is caught in a crisis of identity that can be confusing, and cause her to have trouble articulating her scientific opinion for the court in a manner that feels appropriate to her professional integrity as a scientist. Her expert opinion will be circumscribed by scientific norms, will be qualified on many levels for the sake of scientific rigor, will exist only in terms of possibility and probability, and will be provisional—ideally (from the perspective of scientific discourse) to be improved upon as science progresses. The court will ask her to express that multidimensional, nuanced, and provisional opinion flatly in black and white, and then will treat its shadow projected on the record as a settled fact that can be used to build law that ideally (from the perspective of legal discourse) will remain fixed.

How can a scientist express her opinion in the form sought by the legal process—as though it were fixed in stone, a proper foundation for social order—without compromising her professional integrity?

The voice of the scientific expert witness is equivocal, "having different significations" in the discourses of science and law that may be "equally appropriate or plausible" within the respective disciplines, but become "ambiguous" and vulnerable to "double interpretation" when these discourses meet.[2] I examine the equivocality that inheres in speaking science to law, comparing

1. Pauline Newman, *Law and Science: The Testing of Justice*, 57 N.Y.U. ANN. SURV. AM. L. 419, 427 (2000).
2. OXFORD ENGLISH DICTIONARY ONLINE, EQUIVOCAL, ADJ., A.2.A (2d ed. 1989).

the legal and scientific commitments of the expert witness who is about to testify, providing to the expert witness a framework for understanding the act of her testimony, and offering to judges and juries an insight into the expert witness's discursive situation that may help the fact-finder interpret her testimony. Part II examines the scientific professional commitments to which the scientific expert witness is subject. Part III links these commitments to those governing legal discourse. Part IV examines the situation of the expert witness, who must speak in a way that is recognized as credible and ethical in two distinct professional discourses simultaneously. Part V suggests how lawyers can structure the expert witness's discursive situation better to support her integrity and professional performance in both discourses.

Accordingly, this paper focuses on the situation of the scientific expert who strives to perform ideally as both a scientist and a witness. Scientific experts can fail to observe their ethical responsibilities as scientists and citizens by intentionally distorting the substance of their testimony. For clarity, the situation of an expert who intentionally acts unprofessionally or ignores civic duty is beyond the scope of this paper.

Of course, each experienced expert witness will determine for herself how to manage the divergent norms governing her testimony. This paper focuses on the initial state of a professional scientist coming to speak science to law, to lay out the situation that she must learn to negotiate.

The metaphor of performance describes the situation of the expert witness: she is on stage, called to speak by a legal institution in the ostensibly unified voice of a scientific institution. The primary audiences for her performance are the legal fact-finder(s), the scientific community, and the expert witness herself as its representative. The expert witness's credibility is weighty: it is important to her professional identity as a scientist, it serves as the predicate for her presence upon the stage, and it influences the decision of the legal fact-finder.

An actor's credibility depends upon the conformity of her performance to the audience's expectations. The audience expects the actor to perform in accordance with the norms that characterize proper performance for someone in her role. The expert witness is an actor addressing two genres of audience: both the scientific and the legal. To retain her integrity as a scientist—her credibility in her own eyes and in those of the scientific community—she is professionally bound to testify in a way that does not distort the scientific findings that she must report to the court. But to be credible to the legal fact-finder, she must respond to narrow questions with definite answers that can be readily converted into legal facts. As a result, the scientific and legal modes of her performance are in tension.

Though as a professional actor, the expert witness will strive to maintain her integrity in the shear of conflicting normative obligations, she is unlikely to be able to perform in a way that fully conforms to the diverging scientific and legal sets of discursive norms to which she is subject—that is, to perform professionally.[3] As the pioneering sociologist William Goode explained, a person who plays multiple roles the normative obligations of which cannot all be fulfilled must compromise among her role-based duties.[4] This compromise, or role-bargain, is necessary to reduce the role-strain she experiences to the point where she can function.[5] The expert witness is subject to a set of role-based obligations attaching to her status as a scientist and to a set of role-based obligations attaching to her discursive situation in the courtroom. To the extent that these obligations are in tension, she will be unable to perform with integrity as a professional scientist while under oath[6] as a participant in the legal system.

Thus, the expert witness will perform better in one role at the expense of the other. Because the actor's performance matters—the speech act of her testimony may have powerful effects on determinations of right—it is worthwhile to analyze her discursive situation to determine whether it can be structured to support her integrity and simultaneous professional performance in both discourses.

II. WHAT LAWYERS NEED TO KNOW ABOUT SCIENTIFIC PROFESSIONAL NORMS

Scientific professional norms indicate the boundaries of scientific professionalism: they subtend—both support and limit—the scientist's authority. The question of what counts as professional behavior for a scientist is linked to what counts as rigorous (as distinct from "junk") science: scientists have a responsibility to conduct themselves in a way that promotes the epistemological quality of their research. A scientist must apply scientific research methods with the utmost care, doing all she can to produce results according to these methods that minimize and account for residual subjective biases, so that the results are robust to reproduction and review by a variety of peers. Research results that meet the researcher's high procedural standards, and then emerge from the scrutinizing processes of review for publication and application in future research have a high

3. Deborah M. Hussey Freeland, *Maieusis Through a Gated Membrane: "Getting the Science Right" in Public Decisionmaking*, 26 STAN. ENVTL. L.J. 373, 386–87 (2007). ("'[P]rofessional' denotes one who is not only an expert in his field, but whose work meets its ethical standards; thus, 'professionalism' entails having and heeding one's sense of duty to perform one's job according to those ethics.").

4. William J. Goode, *A Theory of Role Strain*, 25 AM. SOC. REV. 483, 485, 495 (1960) ("[T]he total role system of the individual is unique and over-demanding. The individual cannot satisfy fully all demands, and must move through a continuous sequence of role decisions and bargains, by which he attempts to adjust these demands.").

5. *Id.* at 483 (noting that role strain is "the felt difficulty in fulfilling role obligations. Role relations are seen as a sequence of 'role bargains,' and as a continuing process of selection among alternative role behaviors, in which each individual seeks to reduce his role strain. These choices determine the allocations of role performances to all institutions of the society.").

6. *See, e.g.*, FED. R. EVID. 603 ("Before testifying, a witness must give an oath or affirmation to testify truthfully. It must be in a form designed to impress that duty on the witness's conscience."); IND. R. EVID. 603 ("Before testifying, every witness shall swear or affirm to testify to the truth, the whole truth, and nothing but the truth.").

epistemological quality. These results are the best of our knowledge at the moment, given the limitations of the research that the researching scientist and her colleagues have done their best to identify.

To clarify interactions between law and science, it is helpful to adapt the concept of boundary work for the decisions made by individual professional scientists as they conduct scientific research—as they simultaneously apply the vetting processes for scientific research and undergo the vetting process for researchers who hope to be recognized as scientists. In deploying the term, "boundary-work,"[7] Thomas Gieryn noted that while analytical attempts to solve the problem of demarcation between science and non-science have not been entirely successful, scientists accomplish this demarcation routinely in making curricular, funding, and publication decisions.[8]

Gieryn reasonably suggests that analytical attempts to clarify disciplinary line-drawing fall into oversimplification when they ignore its political aspects. However, his reduction of boundary work to a rhetorical "resource for [scientific] ideologists"[9] oversimplifies grossly in the other direction. Gieryn leaps from the assertion that, "[d]escriptions of science as distinctively truthful, useful, objective or rational" are "incomplete and ambiguous images of science," to the conclusion that this description is made because it is "nevertheless useful for scientists' pursuit of authority and material resources," and suggests that his argument that scientific boundary work is driven by ideological, self-serving motives should end the debates as to the nature of science.[10]

However, when the motive for boundary work is left open, or is replaced with scientific professional ethics, the basic concept of boundary work is most useful. I part with Gieryn's view that the demarcation problem persists because scientists draw their disciplinary boundaries in accordance with a shared, ideology-based, power-seeking motive. As a sociologist, Gieryn is focused at the institutional level, and on the historical emergence of science from the pre-Enlightenment period. He denotes as "science" institutional functions that are not at its heart: even as science education, the public and private funding of science, and scientific publishing affect the development of scientific research results, they are not the same thing as conducting the research itself. The individual researcher who properly sorts science from non-science contributes to progress in her field. The epistemological power of scientific methods is evident in that they produce research results that enable us to understand natural phenomena and affect them intentionally through the technologies we develop. It is because scientific progress leads to deeper understanding of the natural world and makes helpful

7. Thomas F. Gieryn, *Boundary-Work and the Demarcation of Science from Nonscience: Strains and Interests in the Professional Ideologies of Scientists*, 48 AM. SOC. REV. 781 (1983).

8. *Id*. at 781.

9. *Id*. at 791.

10. *Id*. at 792–93.

technologies possible, contributing to the common good, that science and scientists grow in credibility and are allocated authority and resources to do more science. It puts the cart before the horse to claim that an individual researcher decides that the results from a contaminated sample are to be discarded because she wants science as an institution to receive more funding, or that she will present the results of her well-controlled study as her scientific work so that the institution of science will have more political power. The aspects of the institution of science on which Gieryn focuses shed little light on the work of individual scientists in conducting their research.

I adapt the concept of boundary work simply to denote disciplinary demarcation resulting from a scientist's professional assessment of the quality of scientific research, where "professional" signals the good-faith application of disciplinary expertise (that is, she does not decide what is or is not science for an extrascientific motive, like making lots of money or helping a friend). I propose an epistemological concept of boundary work: though other bases for demarcation surely exist, epistemological boundary work is the primary responsibility of the scientific researcher, who is ethically bound to use her professional judgment—rather than political motives—to determine what counts as science.

Judges and lawyers care a great deal about scientific boundary work, especially since *Daubert*[11] allocates to judges the task of determining which claims have scientific authority—what counts as science, and who is a credible scientist. The following sections address the nature and purpose of scientific research, and scientific mechanisms for controlling subjectivity to improve the possibility of our access to increasingly objective knowledge of natural phenomena. The more powerful a finding's claim to objectivity, the more authoritative it will be.

A. WHAT IS SCIENCE?

Entire fields of inquiry in the humanities and social sciences are devoted to the demarcation problem: to describing precisely what science is and is not. For example, philosophy of science,[12] history of science,[13] sociology of science,[14] and critical science studies[15] explore what it is that falls within the boundaries of

11. Daubert v. Merrell Dow Pharms., Inc., 509 U.S. 579, 597 (1993).

12. For an introductory overview, see SAMIR OKASHA, PHILOSOPHY OF SCIENCE: A VERY SHORT INTRODUCTION (2002); *see also, e.g.*, DAVID HUME, A TREATISE OF HUMAN NATURE (D.F. Norton & M.J. Norton eds., 2000); KARL POPPER, CONJECTURES AND REFUTATIONS: THE GROWTH OF SCIENTIFIC KNOWLEDGE (1963); SUSAN HAACK, DEFENDING SCIENCE—WITHIN REASON: BETWEEN SCIENTISM AND CYNICISM (2007); HELEN E. LONGINO, THE FATE OF KNOWLEDGE (2002).

13. *See, e.g.*, THOMAS KUHN, THE STRUCTURE OF SCIENTIFIC REVOLUTIONS (2d ed. 1970); STEPHEN JAY GOULD, ONTOGENY AND PHYLOGENY (1985); PETER L. GALISON, EINSTEIN'S CLOCKS, POINCARÉ'S MAPS (2003).

14. *See, e.g.*, ROBERT K. MERTON, THE SOCIOLOGY OF SCIENCE: THEORETICAL AND EMPIRICAL INVESTIGATIONS (1979); THOMAS GIERYN, CULTURAL BOUNDARIES OF SCIENCE: CREDIBILITY ON THE LINE (1999).

15. *See, e.g.*, JEROME RAVETZ, SCIENTIFIC KNOWLEDGE AND ITS SOCIAL PROBLEMS (1971); BRUNO LATOUR & STEVE WOOLGAR, LABORATORY LIFE: THE CONSTRUCTION OF SCIENTIFIC FACTS (1979).

science, and how those boundaries evolve. These fields are very complex,[16] generating their own knowledge and professionals in diverse schools of thought. Faced with the complexity of this question, scholars examining interactions between law and science must attempt to explain what they mean by "science."

Legal fact-finders should understand the nature of the information they are evaluating. To work effectively with an expert witness, a lawyer needs to know both what legal fact-finders think science is and what scientists think science is. Accordingly, I examine two directly relevant concepts of science: a lay definition of science that will likely reflect what non-scientist judges and jurors think of as science; and an inside view of science as seen by those who produce it and have first-hand knowledge of what they have made. The scientific expert witness's understanding of what her performance means when she speaks in court will originate from her professional ideas of what science is and how it should be treated. As the lawyer prepares the expert to testify, he should be sensitive to what she thinks she is doing, and to the effects of her statements within her professional community. If her statements do not sound like those of a professional scientist, her reputation and career as a scientist are in jeopardy.[17]

Before the Enlightenment, "science" was used generally to denote knowledge gained from experience. The meaning of "science" now is more specific, referring to knowledge produced in accordance with the scientific method,[18] ideally involving controlled experimentation ("hard" science).[19] That the default meaning of "science" in modern usage has been narrowed to refer to this particular kind of knowledge reflects the privilege accorded to the fruits of the scientific method in our linguistic community, which extends to our legal system

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16. Note that the boundaries among these meta-scientific disciplines are not necessarily clear, and that work offered as an example in one category may also count as work in another.

17. For example, overclaiming—attributing more certainty to research results than they really have, or citing research in support of statements that it does not fully support—may be seen as a form of falsification. Falsification is a type of scientific misconduct that:

> strike[s] at the heart of the values on which science is based. These acts of scientific misconduct not only undermine progress but the entire set of values on which the scientific enterprise rests. Anyone who engages in any of these practices is putting his or her scientific career at risk. Even infractions that may seem minor at the time can end up being severely punished.

COMMITTEE ON SCIENCE, ENGINEERING AND PUBLIC POLICY OF THE NATIONAL ACADEMY OF SCIENCES, NATIONAL ACADEMY OF ENGINEERING, AND INSTITUTE OF MEDICINE, ON BEING A SCIENTIST: RESPONSIBLE CONDUCT IN RESEARCH 16 (1995) [hereinafter CSEPP]; *see also* ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT GLOBAL SCIENCE FORUM, BEST PRACTICES FOR ENSURING SCIENTIFIC INTEGRITY AND PREVENTING MISCONDUCT (2007), *available at* http://www.oecd.org/science/scienceandtechnologypolicy/40188303.pdf.

18. I look to the flagship etymological record of the English language, the Oxford English Dictionary, for evidence of the meaning of "scientific method" used by nonscientist judges and juries. OXFORD ENGLISH DICTIONARY ONLINE, SCIENTIFIC, ADJ. AND N., SPECIAL USES S2., SCIENTIFIC METHOD N. (2d ed. 1989) ("a method of procedure that has characterized natural science since the 17th century, consisting in systematic observation, measurement, and experiment, and the formulation, testing, and modification of hypotheses.").

19. OXFORD ENGLISH DICTIONARY ONLINE, SCIENCE, N., 5.B (2d ed. 1989) ("In modern use, [science is] often treated as synonymous with 'Natural and Physical Science'").

and its courts.[20]

From a scientific perspective, "the" scientific method is not one specific recipe for knowledge—its specifics vary over time and field of inquiry—but it fairly may be described as a mode of investigation characterized by cycles of systematic empirical observation and hypothesis formation. This procedural approach to knowledge-production builds on its precedent: controlled experiments and standardized descriptions are designed and performed to test a hypothesis (ideally to challenge the hypothesis, but often to support it); if the results are inconsistent with the hypothesis, the hypothesis (and *not* the results) should be modified to account for the data; and new experiments are designed to test the new hypothesis. This iterative procedure is understood to be asymptotic: science proceeds under a positivistic supposition that the scientist is studying a phenomenon that has an objective reality (that is independent of the scientist's ideas about it)—and the scientist's boundary work can be understood in terms of her professional commitment to sorting the objectively real from the subject-dependent.

In other words, this positivistic assumption is accompanied by a professional commitment to develop a more accurate, more complete understanding of that phenomenon through scientific investigation. This commitment is robust: it holds despite the scientist's useful, skeptical view that we may never fully know or understand the phenomenon the way an omniscient observer might. Thus, a full understanding of the phenomenon itself is an ideal, and the scientific method is a perfectionistic striving that may ever fall short. If the path to understanding (the development of a model of the phenomenon) is shown to lead away from this ideal rather than at least incrementally towards it, then a new path is taken (a new model is developed)—the old, incremental progress usefully has led to a new approach. Science is the best of our knowledge at the moment, given the limitations identified by the researcher and her peers, and other limitations not yet appreciated. By small steps or giant leaps, the goal of science is to keep changing our understanding, moving it closer to complete knowledge.

B. WHAT LAWYERS NEED TO KNOW ABOUT THE PURPOSE OF SCIENCE

The purpose of science is to understand more fully the natural world: to produce empirically based knowledge. But what does it mean to know? This is a philosophical question sounding in epistemology, or theory of knowledge. This section explains how a scientist "knows": how scientists frame and seek truth.

20. Richard D. Friedman, *Minimizing the Jury Over-Valuation Concern*, 2003 MICH. ST. L. REV. 955, 982 (noting that "[m]uch of the rhetoric addressing expert evidence revolves around the possibility that jurors will over-value the evidence. In some cases this seems to be an undeniable possibility," and arguing nevertheless that judges should not exclude expert evidence based on the over-valuation concern).

Science as an institution has developed from the desire for truth[21] (or for the best approximates we can craft, lacking the certainty of a closed and fully defined mathematical system). Scientists attempt to derive an ever more complete understanding of a posited objective reality—a more true understanding of the world—from points of empirical information. The "objective" is that which pertains to the objects of thought or perception, to material things that we can observe, "as distinct from the [thinking or perceiving] subject."[22] Thus, objective reality is what it is, regardless of what any or all of us do, or want it to be.

Seeking recognizable access to objective reality, scientists turned from faith in religious texts to their own senses as a source of knowledge.[23] This move from fundamentalism to empiricism challenged the authority of the religious professional class, and empowered the common man to contribute to a common understanding of the world of human experience. Thus, science depends on the idea that there is a universal reality that exists independent of any particular, incomplete subjectivity, and that undistorted glimpses of parts of that objective reality are accessible to human minds. Whether or not the idea of a posited objective reality that is accessible to subjective human cognition is necessary to the production of science, this doxastic commitment is part of the Cartesian heritage of science.[24]

1. Subject-Object Dualism

The distinction between a knowing subject and an object of knowledge fits the empirical turn of post-Enlightenment science. The scientist takes a guess about the structure or function of a physical system, plans an action that is precisely directed to affect a single element of it, and predicts how the system would respond to the action if her hypothesis about its structure or function were correct. This method situates the scientist as a subject who can learn, or come to know, propositions about the system through controlled experimentation. Propositions about the system are true if they accurately describe, or correspond to, the

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21. OXFORD ENGLISH DICTIONARY ONLINE, TRUTH, N., II.5.A (2d ed. 1989) ("Conformity with fact; agreement with reality; accuracy, correctness, verity (of statement or thought)."). Even this lay definition of truth reflects the positivistic philosophical perspective of modern science: the correspondence theory that a truth is a proposition that accurately reflects an aspect of an objective reality. *See, e.g.*, Marian David, *The Correspondence Theory of Truth*, THE STANFORD ENCYCLOPEDIA OF PHILOSOPHY (Edward N. Zalta ed., Fall 2009), *available at* http://plato.stanford.edu/archives/fall2009/entries/truth-correspondence.

22. OXFORD ENGLISH DICTIONARY ONLINE, OBJECTIVE, ADJ. AND N., A.III.B (3d ed., Mar. 2004).

23. It is debated whether we perceive reality directly, or whether perception is mediated by sense-data, subjective representations of the external world that are themselves what we actually perceive. *See, e.g.*, BERTRAND RUSSELL, THEORY OF KNOWLEDGE 66, 93–94 (E.R. Eames, ed., 1984).

24. RENÉ DESCARTES, *Discourse on the Method of Properly Conducting One's Reason and of Seeking Truth in the Sciences*, *in* Discourse on the Method and Meditations 49 (F.E. Sutcliffe, trans., 1968) ("For, God having given each of us some light of reason to discern true from false, I could not . . . content myself . . . with the opinions of others, if I had not intended to use my own judgement to examine them in due course[.]").

objectively real, physical system.

This posited dichotomy between a subject and an object can be criticized as a contrived view of a human subject's relation to physical reality. We are embedded in physical reality and cannot find a subject-position apart from it. Further, since we are not omniscient, our observations of physical phenomena are shaped and constrained by our subjectivity. Thinking in terms of a perceiving subject and perceived object may be too simplistic and lead to philosophy that is not fully satisfactory.

Yet so far, we have been able to learn a great deal about the physical world using a scientific method based on this dichotomy. The physical sciences have yielded knowledge sufficiently robust to support remarkable engineering advances in fields from medicine to electronics to materials science. Though knowledge produced by the physical sciences is not known to be perfect, the best of our knowledge has been demonstrably good enough to allow us to develop technologies that extend our capabilities. Operationally, scientific research relies on disentangling object from subject.

2. Truth as Justified Belief

Epistemologists have long worked to develop our understanding of knowledge, and are still embroiled in the task. To narrow the field of inquiry and choose a starting-point, traditional epistemologists have focused on what it means to know a proposition: what does it mean that '*S* knows that *P*,' where '*S*' is the knowing subject, and '*P*' is the proposition that is the object of *S*'s knowledge? This organization of the question allows an epistemologist to draw from both logic and the philosophy of language to build a concept of knowledge that facilitates the present inquiry.

What exactly is knowledge of a proposition? Epistemologists have further framed the question supposing that knowledge means justified, true belief in the proposition: *S* knows that *P* if and only if *P* is true and *S* is justified in believing that *P*. This framing requires justification, truth and believing to be defined. Using the correspondence theory of truth on which science is based yields the definition of "truth" given above, that of accurate representation of reality. To "believe" is to accept as if true.[25]

A "justified" belief has been described as a belief that is true for some reason other than random happenstance.[26] An ideal, objective truth is true whether or not anyone believes it[27] (like the tree that falls in the forest, producing pressure-waves whether or not anyone hears them). From the skeptical perspective of a

25. OXFORD ENGLISH DICTIONARY ONLINE, BELIEVE, V., 3.A. (3d ed. Sep. 2011).

26. Matthias Steup, *Epistemology*, THE STANFORD ENCYCLOPEDIA OF PHILOSOPHY (Edward N. Zalta ed., Win. 2011), *available at* http://plato.stanford.edu/entries/epistemology.

27. Susan Haack, *Of Truth, in Science and in Law*, 73 BROOKLYN L. REV. 985, 995 (2008).

scientist, truths exist but we may not know that we know them. Accordingly, belief may never be justified—or at least we will not know that it is—in that research results are always provisional. However, scientists still, provisionally, deem some propositions more worthy of belief than others.

The concept of truth as justified belief better fits the litigation process in which we seek justification for acting as if a set of facts were true, and then act upon them as if we believe them.[28] There are two major sources of epistemological justification: evidentialism and reliabilism.

a. Evidentialism

Evidentialists take a belief to be justified to the extent that it coherently accounts for evidence possessed by the knowing subject. This evidentialist position describes one of the criteria used by scientists to regard a proposition as being more likely to be true: a proposition that accounts for more of *S*'s observations or experimental results is treated as a better proposition—a proposition that is more likely a true representation of reality—than is a proposition that accounts for fewer observations.

Scientists go further: among propositions that account for the same set of observations, scientists prefer the more parsimonious proposition to the more complex.[29] Eventually, as scientist *S* learns more about the system under study, a more complex account of the data may be preferred after all—but at any given moment there is a cultural commitment to favor the least complex account of reality (the explanation that is said to have the most "elegance"[30]). Scientists require their belief in a proposition to be constrained by evidence, and are thus evidentialists in their approach to knowledge-production.

b. Reliabilism

Reliabilists take a belief to be justified (or true for some reason other than luck) if and only if the belief is based on reliable cognitive processes. This view brings to mind Bertrand Russell's argument that sense-data are the only objects that can be known,[31] and aptly describes another set of criteria that scientists rely on in determining which propositions are more likely true than others: a scientist takes great care to follow the protocols of her field for developing a new point of knowledge, and the quality of her performance of those protocols will be assessed by other scientists in her field, including advisors, students, co-authors,

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28. *See infra* Part III.B.

29. This epistemological aesthetic of science is called the law of parsimony, or "Ockham's razor." *See, e.g.*, OXFORD ENGLISH DICTIONARY ONLINE, OCKHAM'S RAZOR, N. (3d ed. Mar. 2004) ("The principle that in explaining anything no more assumptions should be made than are necessary.").

30. *See, e.g.*, CSEPP, *supra* note 17, at 10.

31. *See* RUSSELL, *supra* note 23.

and competitors. The scientist's own commitment to methodological rigor, along with various modes of peer review by her scientific communities, all reflect scientists' reliabilist approach to producing knowledge, or points of information that correspond to a real object and thus warrant belief—at least until even more rigorously produced knowledge is available.

Scientists take reliabilism further by combining reliabilistic approaches to their inquiry, openly favoring multidisciplinary approaches to framing and understanding a physical phenomenon. A multidisciplinary research strategy allows the acknowledged limitations of one mode of inquiry to be complemented by the use of other modes with different kinds of limitations. A model of immune-system function, for example, that results from multidisciplinary study and is robust to critical examination from a variety of fields is thought to be more likely true: its claim to objectivity seems stronger, and belief in its accurate correspondence to objective reality seems more justified than is belief in a model that finds support in fewer fields of inquiry—that is less diversely grounded.[32]

c. *Belief and Skepticism*

Despite their approach to knowledge-production that combines the criteria of these two distinct strains of epistemology, the concept of knowledge seems softer for scientists than it would be for either evidentialists or reliabilists who feel that justified belief is a sufficient basis for knowledge. For scientists, belief is never fully justified. Belief still requires a leap of faith—and even if the leap is taken, belief remains defeasible by the results of the next experiment. Truth is an elusive ideal: the correspondence theory allows data to mirror truth only to the extent that signal is distinguishable from noise, and the response of the system studied can be disentangled from artifact produced by tools or methods of measurement and calculation. Experimental data speak most directly about the physical world; models and theories are further removed by derivation and construct, to the point where a scientist does not know whether and to what extent her model of molecular function or subatomic structure *truly* fits or mirrors a natural phenomenon. The model is provisional: it is used to design additional experimental approaches until its ability to account for the resulting data meets stubborn limits—then, the model must be revised. This process is amusedly called by scientists, "pushing back the frontiers of knowledge":[33] scientists understand

32. This reasoning has provided the basis for the development of multidisciplinary research centers and conferences focused on a variety of research questions. *See, e.g.*, YALE SCHOOL OF MEDICINE, CENTER FOR NEUROSCIENCE AND REGENERATION RESEARCH, *available at* http://medicine.yale.edu/cnrr/index.aspx; AMERICAN ASS'N FOR CANCER RESEARCH, TUMOR IMMUNOLOGY: MULTIDISCIPLINARY SCIENCE DRIVING BASIC AND CLINICAL ADVANCES, *available at* http://www.aacr.org/home/scientists/meetings--workshops/special-conferences/tumor-immunology-multidisciplinary-science-driving-basic-and-clinical-advances.aspx; COLUMBIA UNIVERSITY, ENERGY FRONTIER RESEARCH CENTER, *available at* http://www.cise.columbia.edu/efrc.

33. *See, e.g.,* UNIVERSITY OF CAMBRIDGE, THE KAVLI FOUNDATION ("For centuries, the University of

their work to be a striving for deeper, fuller understanding that will never be complete, like the exploration of a space—of a "final" frontier that is infinite. A scientific attitude towards research is skeptical in effect, but not in affect: the scientist is effectively skeptical in that she never stops her work as she would if she were to believe that she had attained true knowledge—reached her goal—and yet she strives for true knowledge as if the hope of its attainment were real.

C. WHAT LAWYERS NEED TO KNOW ABOUT HOW SCIENCE GRAPPLES WITH SUBJECTIVITY

Because no person, no scientist, is omniscient, no scientist can escape subjectivity. We have incomplete information about the universe, and our guesses as to what any universal truths might be are constrained by and biased because of that incompleteness. Scientific procedures are calculated to neutralize subjectivity. In addition to the work of individuals to account for and minimize subjective influences on their research results, the institution of science enables us to pool our limited understandings in a very organized way, to share our individual perspectives, and to test their correspondence with our collective insights—our best approximations to objectivity.

A scientist who thinks that she has seen something that might exist in itself (rather than as an artifact of her investigation) can alert others to its location, so that they may follow the steps to the vantage point she has found, and see it for themselves. Another scientist will guess that if the object really is as it appears, he should be able to come to it by another route; he will follow this hypothesis, and report the results to others. Eventually, a consensus may form around the object, that it indeed exists and is as we collectively describe it—until someone later, with better gear, more talent for cartography, or both, finds a way to demonstrate to the community that we were misled because the object is actually of a different nature from what we had thought. This new understanding, or model, of the object may in turn suggest a lot of different ideas about what objective reality may be like. This model will be tested, and new consensus may then form around it. Thomas Kuhn has used the term "paradigm shift" to describe this process of consensus-shifting around different models.[34] Similarly, the National Academy of Sciences describes the use of consensus to mitigate subjective bias:

> One goal of [the methods scientists use in doing and reporting research] is to facilitate the independent verification of scientific observations. . . . By adhering to these techniques, researchers produce results that others can more easily

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Cambridge has been pushing back the frontiers of knowledge about the universe."), *available at* http://www.kavlifoundation.org/university-cambridge.

34. THOMAS S. KUHN, THE STRUCTURE OF SCIENTIFIC REVOLUTIONS (2d ed.1970).

> reproduce, which promotes the acceptance of those results into the scientific consensus.[35]

Furthermore, "[t]his ongoing process of review and revision is critically important. It minimizes the influence of individual subjectivity by requiring that research results be accepted by other scientists."[36]

To evaluate the strength of scientific consensus, scientists consider not only its size but also its heterogeneity. Scientists value multidisciplinarity not only for its benefits from a reliabilist perspective, but also as a way to compensate for subjectivity: bringing not only a larger number, but also a greater *variety* of subject-positions together to form an understanding of a problem can strengthen the claim to objectivity of that understanding, because it emerges from the convergence of a more diverse set of incomplete subject-positions. As various fragments of the map are pieced together, their overlap clarifies the redundantly observed terrain, and some terrain is captured in one fragment but not in another.

Feminist theorists of science also have indicated that the more diverse the group of perspectives that can see the same object, the stronger should be the claim that the object is not an artifact of subjectivity, but that it corresponds to a positive objective reality.[37] Objectivity is a scientific *ideal*, the pursuit of which shapes the way scientists go about their work. Peer review and the availability of results for scrutiny, challenge, and amendment in the scientific literature are seen to contribute to the objectivity of science.[38]

Thus, in addition to aspiring and striving individually to be objective, scientists can act collectively through consensus formation to identify and counterbalance individual subjective biases. Lawyers need to know that scientific professionalism requires collective checking and compensation for individual subjective biases.

D. WHAT LAWYERS NEED TO KNOW ABOUT HOW SCIENCE CLAIMS OBJECTIVITY

The mode by which science progresses can be framed in terms of objectivity-claiming: claims of access to objective truth are tested, and the more testing the claim survives—the more robust it is—the wider the consensus of opinion in the scientific community that accepts the objective truth of the claim. Very robust objectivity claims are provisionally treated as fixed points: so many of their dependent objectivity-claims have seemed to hold true that the fundamental

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35. CSEPP, *supra* note 17, at 4.

36. *Id.* at 3.

37. SANDRA HARDING, WHOSE SCIENCE? WHOSE KNOWLEDGE?: THINKING FROM WOMEN'S LIVES (1991); EVELYN FOX KELLER, SECRETS OF LIFE, SECRETS OF DEATH: ESSAYS ON LANGUAGE, GENDER AND SCIENCE (1992).

38. CSEPP, *supra* note 17, at 8 ("The social mechanisms of science . . . help eliminate distorting effects that personal values might have. They subject scientific claims to the process of collective validation, applying different perspectives to the same body of observations and hypotheses.").

claim begins to be taken for granted and regarded, however tentatively, as "fact." The most robust claims are called "laws."

1. The Role of Provisionality in Objectivity-Claiming

In order for an objectivity claim to be taken seriously by the scientific community, it must be made through rigorous application of the standard empirical method (the scientific method), which is rooted in skepticism towards the current hypothesis because it is likely incomplete. Experiments that would demonstrate the incorrectness of the hypothesis should be favored, because hypotheses can be refuted but not proven. That is, experimental hypotheses cannot be proven in a mathematical sense,[39] even if they may be described in mathematical terms: mathematicians can produce proofs about mathematics because they can define and thus know every element of the universe of their study. Scientists, in contrast, study objects, systems, or processes that are given by nature, the elements of which scientists are continually seeking to identify and explain. Even billions of data-points, or experimental results, that are consistent with a hypothesis are not taken to establish its truth. Rather, scientists acknowledge that some day, a more complete model of the objective universe might reveal flaws in even those objectivity-claims that have long been our most robust.[40] That is why even well established products of scientific research, the implementation of which has resulted in technological developments such as computers and cures for diseases, are termed the "theory of electromagnetism" or "germ theory." These empirically borne-out understandings are called "theories" in the very careful acknowledgment that they might be revised. Science is understood to be provisional; this provisionality motivates more and more scientific study, and is thus vital to the scientific enterprise.

2. The Nature of a Scientific Fact

Scientific "facts," therefore, are not set in stone. Objectivity claims are most persuasive when they have been made through impeccable application of the scientific method, when they can be reproduced by independent scientists, and when they fit other aesthetic criteria. Qualities that strengthen an objectivity claim within the scientific community are its internal consistency, and its power to explain other phenomena—that is, to contribute to a narrative, or story, that suggests causal relationships between correlated observations. Simpler explanations are preferred to more elaborate ones, although in theory, the more elaborate explanation might better correspond to an objective truth. Completeness of

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39. OXFORD ENGLISH DICTIONARY ONLINE, PROVEN, ADJ., 1. (3d ed. Mar. 2004) ("Shown to be true").

40. CSEPP, *supra* note 17, at 15 ("Scientific results are inherently provisional. Scientists can never prove conclusively that they have described some aspect of the natural or physical world with complete accuracy. In that sense all scientific results must be treated as susceptible to error.").

explanatory power and predictive power are especially prized.

Nevertheless, the most rigorous scientists remain wary of even the most persuasive objectivity claims. They are keenly aware of the limitations of their subjectivity: that even the best scientists are like the blind men of parable who felt an elephant—one deemed it to be most like a snake, another, a wall, and another, the trunk of a tree. Lawyers need to know that to a scientist, her research results may not appear to be stable enough to use as a basis for law—even though to a lawyer, science may appear much more stable than other existing legal foundations. As the National Academy of Sciences explains:

> Science results in knowledge that is often presented as being fixed and universal. Yet scientific knowledge obviously emerges from a process that is intensely human, a process indelibly shaped by human virtues, values, and limitations by societal contexts. How is the limited, sometimes fallible, work of individual scientists converted into the enduring edifice of scientific knowledge? The answer lies partly in . . . [its] openness to new scientific contributions and persistent questioning of those contributions and [of] the existing scientific consensus.[41]

This hallmark of scientific professionalism may wreak havoc as it manifests in the scientist's performance on the stand: the expert witness who persists in questioning the substance of her testimony may cause even well settled science with the strongest objectivity-claims to appear uncertain and weak to a legal fact-finder.

E. WHAT LAWYERS NEED TO KNOW ABOUT RESIDUES OF SUBJECTIVITY IN SCIENCE

Although scientific procedural practices do much to account for the subjective limitations of individual scientists, the residue of subjectivity persists in even the best-made science. The sections below indicate how scientists strive to sort their personal value judgments from their independent professional judgment and articulate how the former informs the latter, how the scientist's need to express uncertainty—which identifies residues of subjectivity in her interpretations of her research results—is essential to her scientific professional identity, and how the collective judgments of a society can affect the development of its science at the level of supporting research in chosen fields. Thus, even as scientists strive to limit subjective influences on their work individually and collectively, residues of subjective judgment remain. The professional scientist is duty-bound to acknowledge these limitations so that others can properly understand the scope of her work, and rely on it accordingly.

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41. CSEPP, *supra* note 17, at 2.

1. Independent Professional Judgment

> *When [personal] judgment is recognized as a scientific tool, it is easier to see how science can be influenced by [scientists'] values. Consider, for example, the way people judge between competing hypotheses. In a given area of science, several different explanations may account for the available [observations] equally well, with each suggesting an alternate route for further research.*[42]

As far as we can tell, scientists will retain their subjectivity. Indeed, as with linguistic communication, the miracle may be that science "works"[43] at all.

Part of the professional scientist's boundary work is to sort personal values from professional evaluations. The norms of scientific culture exhort scientists to suspend their feelings and subjective perspectives in the course of performing research that consumes their thoughts and time. In their efforts to remain responsible to the norms of scientific culture, scientists can thus become irresponsible—literally unable to answer—to society for their actions. Meanwhile, individual scientists' personal values can color their opinions:

> The challenge for individual scientists is to acknowledge and try to understand the suppositions and beliefs that lie behind their own work so that they can use that self-knowledge to advance their work.[44]

Scientific discourse does not invite professional scientists to articulate their personal feelings about their work. Therefore, even when her political or ethical feelings do affect her opinions, the scientist herself may not be able to assist the legal fact-finder in recognizing this. The lawyer who works with an expert can take the time to help the scientist identify and articulate her beliefs about the meanings, limitations, and implications of her research, signaling shifts between her professional interpretation of her findings and the personal beliefs that have been shaped by her findings.[45]

To be sure, drawing such a boundary is not always straightforward—and since

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42. *Id.* at 6.

43. Note that science cannot be said to "work" unless its task has been set, and on a large scale, setting the task—choosing what kinds of research to fund—is a political process. EVELYN FOX KELLER, SECRETS OF LIFE, SECRETS OF DEATH: ESSAYS ON LANGUAGE, GENDER AND SCIENCE 5 (1992); *see also infra* Part II.E. In this way, the substantive goals of science reflect subjective choices beyond the professional.

44. CSEPP, *supra* note 17, at 8.

45. Stephen Schneider's advice to fellow scientists who are asked to advise the public is analogous:

> [W]e should thoroughly explain how we arrive at our conclusions to those asking us for expert opinion. This explanation should include an explicit accounting of our personal value judgments, if we offer any. I do not hesitate to give such personal judgments when asked, as I, too, am a citizen entitled to preferences, but I always preface any such offerings by saying that my personal judgment is an opinion about how to take risks—not an expert assessment of the probabilities and consequences of future events.

STEPHEN SCHNEIDER, SCIENCE AS A CONTACT SPORT 229 (2009).

a scientist cannot think from a perspective outside of her subject-position, it is in some sense impossible. Yet the professionalism of both the scientist and the judge entails drawing exactly this kind of distinction: a self-effacing strife to bracket her personal preferences while reporting the science, or the law.[46] Performing professionally as a scientist is even more challenging for the expert witness whose professional identity is founded on her neutrality, but whose presentation to the legal fact-finder is framed by her appearance as a partisan witness: the scientist's professional identity is threatened by the likelihood that she will be misread as an advocate. After the work of determining her neutral opinion, she speaks from a position associated with partisan bias:

> [W]hen scientific issues arise in litigation, the judge expects that science and scientists will simply present objective truth. On this expectation, judges find it hard to understand that established scientists can hold opposing views on quite basic questions. With the aura that scientific truth is objective and absolute, having only one correct answer, when judges are presented with differences of scientific opinion, in the form of conflicting expert testimony, we think that someone must be lying.[47]

To maximize their ability to perform professionally, a common sense of professionalism is inculcated in all scientists during their education—before they enter a specific sector and field and thus find their niches in the scientific ecosystem. Science is not a homogeneous endeavor: as an institution it consists of work in different sectors (academic, industrial, government), disciplines, and subdisciplines (biology/protozoology, chemistry/metallocene catalysis, and physics/plasma physics, for example). Even though scientists will end up working in different environments and scientific subcultures, the cultural values of their common academic formation are fundamental to their professional judgment.

Expert witnesses are most likely to be applied scientists or engineers. Their professional identity as scientists is formed in an academic setting. Because of the formative power of engaging in basic academic research, this paper focuses on science as basic academic research, as distinguished from applied research or engineering. Basic research operates at the most fundamental levels of our understanding, without the prior constraints of a commitment to a predetermined outcome. This endeavor has the greatest potential for our learning something new. As Nobel Laureate in Physics Douglas Osheroff puts it, "[t]o have rapid progress, one must support scientific research broadly, and encourage scientists

46. *See* Freeland, *Maieusis Through a Gated Membrane*, *supra* note 3, at 380–81 (characterizing this professional requirement as the "maieutic ethic"); Deborah M. Hussey Freeland, *What Is a Lawyer? A Reconstruction of the Lawyer As an Officer of the Court*, 31 ST. LOUIS UNIV. PUB. L. REV. 425, 486–87 (2012) (describing maieusis as boundary work, and comparing the lawyer's maieutic capacity to Daniel Markovits' negative capability. *See* DANIEL MARKOVITS, A MODERN LEGAL ETHICS: ADVERSARY ADVOCACY IN A DEMOCRATIC AGE (2008)).

47. Newman, *supra* note 1, at 425.

to interact with one another and to spend some of their time satisfying their own curiosit[y]. . . . .This is how advances in science are made."[48] Basic research is like the goose that lays the golden eggs: "Basic research does not necessarily produce results that are immediately relevant . . . , but the knowledge gained often is essential for progress in the various steps involved in new discoveries."[49] In other words, basic scientific research is upstream of applied research and engineering: if the fountains of knowledge are suppressed, downstream developments will be exhausted, and the technologies and economies that they support will wither. The academy is the font of basic science, and all scientists, regardless of their eventual specialization, are formed to their profession through intensive academic education.

Independent scientific judgment is a hallmark of scientific professionalism. Lawyers need to be aware that it is the professional judgment of the scientist that is most helpful to the legal professional (whether judge, lawyer, legislator, administrator, or scholar). Someone who is committed to the independent study of a scientific problem according to the practices, norms, and ethics of scientific culture can provide the most, and most reliable, information about the problem to legal decisionmakers.

2. Reputational Capital and the Need to Express Uncertainty

Just as judges must avoid impropriety (and the appearance of impropriety) to maintain their legitimacy,[50] scientists must avoid bias (and apparent bias) to maintain their credibility.[51] In the formational culture of basic, academic science, a scientist's reputation as a researcher of impeccable professionalism is essential to her ability to exist and to perform as a scientist—to her professional identity. A lawyer who works with a scientist or relies on her research needs to understand that a threat to a scientist's reputation is a threat to her ability to be a scientist. Reputational capital, built on the integrity of her research, is the coin of her realm.[52]

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48. Douglas Osheroff, *How Advances in Science Are Made*, STANFORD, *available at* http://www.stanford.edu/dept/physics/people/faculty/osheroff_docs/06.04.21-Advances.pdf (last visited Apr. 20, 2013) (ellipses in original).

49. Lise M. Stevens, *Basic Science Research*, 287 JAMA, Apr. 3, 2002, at 1754.

50. Caperton v. A. T. Massey Coal Co., 556 U.S. 868, 888 (2009) ("A judge shall avoid impropriety and the appearance of impropriety." (citing ABA Annotated Model Code of Jud. Conduct, Canon 2 (2004))).

51. SCHNEIDER, *supra* note 45, at 208 (providing advice to young scientists).

52. Authorship builds careers in academic science; plagiarism and fabrication or falsification of data are career-destroying frauds. *See supra* note 17. *See also* Alvin M. Weinberg, *Science and Trans-Science*, 10 MINERVA 209, 217–18 (1972) ("The validity of scientific knowledge is established and maintained through the critical judgement of scientific peers. . . . . [T]o be accepted as a scientist—one's scientific credentials must be acceptable."); *See generally* Katherine Shim, *Baltimore Regrets Fraud: Apologizes for Defense of Fabricated Data*, THE TECH, May 7, 1991, at 1, 13 (regarding the example of the effects on Nobel Laureate David Baltimore of falsification in his laboratory).

To understand the testimony of a scientific expert witness, legal professionals need to recognize that a professional scientist is deeply invested in the quality of her research, and that its quality increases the more carefully any subjective biases that might affect it are identified, accounted for, and controlled for. Thus, the effort exhaustively to identify and assess sources of error and uncertainty in scientific research signals its rigor and high quality. A scientist who is asked to downplay or to fail to express uncertainties is being asked to perform unprofessionally; a lawyer who asks her to distort scientific uncertainties threatens her professional identity and asks her to jeopardize her reputation.

When a scientific expert witness is identified for the audience as a scientist, but is asked to speak in a way that a scientist would not, the scientist may experience two forms of social identity threat[53]: distinctiveness threat[54] and acceptance threat.[55] Her legal discursive situation is not her home environment, yet she may feel that she is being asked to speak, and she may try very hard to speak, as if she were at home.

To be effective in preparing an expert witness to testify, distinctiveness threat to the scientist's professional identity should be mitigated. To the scientist who has invested several years in the formation of not only her scientific career but also in her identity as a scientist, this "distinct and meaningful group identity"[56] is expected to be fundamentally important. This distinctive professional identity is not only a source of her personal identity, but is itself "something that will be actively protected when threatened."[57] To mitigate the potential for distinctiveness threat when the scientist feels like a fish out of water, the lawyer should explain to the scientist significant differences between her normal speech situation in her home discourse and her special speech situation in the legal discourse, and point out that the scientist can translate her research reports to fit the scientific sophistication of her audience and the goals of the legal process in which she is involved.

For example, the legal fact-finder is more likely to misconstrue or disregard her expert opinion if he finds it inaccessible.[58] On the other hand, if the scientist

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53. Nyla R. Branscombe *et al.*, *The Context and Content of Social Identity Threat*, in SOCIAL IDENTITY: CONTEXT, COMMITMENT, AND CONTENT (R. Ellemers *et al.*, eds. 1999).

54. *Id.*; *see also* Y. Jenny Xiao and Jay J. Van Bavel, *See Your Friends Close and Your Enemies Closer: Social Identity and Identity Threat Shape the Representation of Physical Distance*, 38 PERSONALITY & SOC. PSYCH. BULL. 959, 969–70 (2012).

55. Branscombe, *supra* note 53; *see also* C. Nathan DeWall *et al.*, *Social Exclusion and Early-Stage Interpersonal Perception: Selective Attention to Signs of Acceptance*, 96 J. OF PERSONALITY & SOC. PSYCH. 729 (2009).

56. Branscombe, *supra* note 53, at 43 (finding that the distinctiveness of one's identity is so important that it would be protected even if the identity were not to have a high social status).

57. *Id*. at 44.

58. SCHNEIDER, *supra* note 45, at 230 ("Scientific jargon is effective for communicating with other scientists, but is often misunderstood in the public arena and increases the probability that a scientist will be 'boxed in,' misquoted, or, more likely, ignored altogether.").

clearly communicates the assumptions on which her research is based, the uncertainties that remain, and the need for future research—as she must when speaking to her scientific peers—she risks being misunderstood by the legal fact-finder—especially when opposing counsel seizes on the assumptions, uncertainties, and provisionality of her work to argue (ironically) that it is not good science—that she does not really know what she is talking about.[59]

However, if the expert witness changes her explanation of her research to downplay its epistemological limitations, she becomes subject to acceptance threat, the concern that she will be rejected by her peer group of scientists for her unprofessional performance.[60] This concern is so powerful that it can have physiological effects, such as increased blood pressure.[61] The concern is real: the late atmospheric scientist Stephen Schneider described this problem of the scientific expert advising the public as the "double ethical bind" of how to communicate scientific research results both honestly (by the standards of one's scientific peers) and effectively (in a way that will be properly understood by the public).[62]

Lawyers need to know that a scientist who resists framing her work in terms of too-high certainty—overclaiming—is not simply being uncooperative, but instead is striving to maintain her social identity.[63] From a legal perspective, we

59. *See, e.g.*, NAOMI ORESKES & ERIK M. CONWAY, MERCHANTS OF DOUBT 106 (2010):

> [O]ne thing we do know for sure is that doubt-mongering about acid rain—like doubt-mongering about tobacco—led to delay, and that was a lesson that many people took to heart. In the years that followed, the same strategy would be applied again, and again, and again . . . [o]nly next time around, they would not merely deny the gravity of the problem; they would deny that there was any problem at all. In the future, they wouldn't just tamper with the peer review process; they would reject the science itself.

See also David Michaels & Celeste Monforton, *Manufacturing Uncertainty: Contested Science and the Protection of the Public's Health and Environment*, 95 AM. J. PUB. HEALTH S39, S40 (2005) ("According to one tobacco industry executive: '*Doubt is our product* since it is the best means of competing with the 'body of fact' that exists in the minds of the general public. It is also the means of establishing a controversy . . . .'" (citation omitted) (emphasis retained)); SCHNEIDER, *supra* note 45, at 259 ("The political chicanery of ideologists and special interests has misframed the climate debate as bipolar—'end of the world' versus 'good for you,' the two lowest probability outcomes—and the media often carries it in that frame.").

60. ORESKES & CONWAY, *supra* note 59, at 50.

61. Daan Scheepers et al., *Suffering from the Possibility of Status Loss: Physiological Responses to Social Identity Threat in High Status Groups*, 39 EUR. J. SOC. PSYCHOL. 1075, 1077, 1082, 1088 (2009).

62. SCHNEIDER, *supra* note 45, at 212–19 (describing the reputational harms suffered by the author despite his preeminent status in the field).

63. Scientists who overclaim (or appear to overclaim) are disrespected for their lack of professionalism. *See, e.g.*, Malcolm W. Browne, *Physicists Debunk Claim [o]f a New Kind of Fusion*, N.Y. TIMES, May 3, 1989, at A1 ("Dr. B. Stanley Pons, professor of chemistry at the University of Utah, and his colleague, Dr. Martin Fleischmann of the University of Southampton in England, touched off a furor by asserting on March 23 in Salt Lake City that they had achieved nuclear fusion in a jar of water at room temperature." The scientists had announced their results to the press, rather than proceeding through the peer review process. A prominent peer scientist described their announcement as "a result of 'the incompetence and delusion of Pons and Fleischmann.' The audience of scientists sat in stunned silence for a m[o]ment before bursting into applause."), *available at* http://partners.nytimes.com/library/national/science/050399sci-cold-fusion.html; Michele Landis

ostensibly call upon the scientist to speak *as a scientist* to inform legal decisionmaking, and yet in our efforts to translate her professional speech into terms that are most helpful to the fact-finder, we distort her speech by minimizing precisely the terms she needs to use to signal her rigor, care, and professionalism as a scientist.[64]

Fortunately, there are synergies between scientific professionalism and the goals of legal decisionmaking processes. Rather than try to elicit scientific information in a way that no professional scientist would want to be associated with, lawyers can learn to point out that science functions as the best of our knowledge about the observable world precisely *because of* its care to establish an empirical basis for its claims, to continue to challenge those bases, and to avoid making claims that are not epistemologically warranted.[65] For example, the legal system's main goal in litigation is to create social order through dispute resolution that it publicly trusts to follow impartial procedures and produce just—or at least legitimate—outcomes.[66] A judge's decision in litigation has the greatest chance of legitimacy and justice if it is based on our best knowledge, our most honest and accurate accounts of real-world events—if it is based on legally found facts of the highest epistemological quality. If a judge were to base his opinion on lies or misleading facts, our confidence in his ability to produce a fair decision would be lessened.[67] Similarly, when a legislature enacts a law or an agency promulgates a regulation, our faith in its fairness and potential effectiveness are compromised if the law or regulation are based on incorrect ideas, or facts, about the real world. The legal system and the public it serves benefit most from the least biased science.

3. Science and Society

Although the administration of science has a hierarchical structure, scientific

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Dauber, *The Big Muddy*, 57 STAN. L. REV. 1899, 1901 (2005) ("The work of the obscure Utah chemists was found to be shoddy, and their reputations were ruined.").

64. SCHNEIDER, *supra* note 45, at 208:

> Scientists think that advocacy based on a "win for the client" mentality that deliberately selects facts out of context is highly unethical. Unaware of how the advocacy game is played outside the culture of scientific peer review, scientists can stumble into the pitfall of being labeled as advocates lobbying for a special interest, even if they had no such intention.
>
> When a scientist merely acknowledges the credibility of some disputed information, opposing advocates often presume the expert (scientist) is spinning the information for some client's benefit.

65. Newman, *supra* note 1, at 425:

> The procedures of trial, the rules of evidence, and the techniques of cross-examination all expose the doubts and uncertainties inherent in the practice of science. However, as judges come to understand that the continuing questioning of results is a strength, not a weakness, of the scientific method, the processes of adjudication should be enhanced, to the larger benefit of both law and science.

66. MARKOVITS, *supra* note 46, at 177–78.

67. Newman, *supra* note 1, at 419.

decisionmaking at the level of individual scientists relies on consensus-formation processes that are more democratic than authoritarian. If a theory or interpretation is proposed by a member of the scientific community, any other member can challenge it, and criteria for what counts as a valid challenge are widely accepted. In order to avoid overclaiming, a lawyer who attempts to rely on scientific authority must bear in mind that democratically determined scientific authority has many voices.

Like the scientific method operating at the level of individual scientists, the process of anonymous peer review, the value of reproducibility, and other aspects of the collective function of scientific institutions do much to account for the subjective limitations of individual scientists. Nonetheless, the choices of which research areas to develop, whose research proposals to fund, which models to promote, which technologies to develop, and the manners and circumstances in which the technologies should be used are not independent of any observer. These are choices that reflect the common and negotiated interests of groups of scientists and administrators. By making these decisions, scientists and engineers allocate their own and their society's human and natural resources based on their opinions of how (and what) science should unfold. These choices are all pivotal decisions that determine how we develop science and to what end.

Beyond the Congressional appropriation of funds to an agency like the National Science Foundation, these choices are largely made within scientific communities. Scientific cultural norms, such as open communication of research results and basing valuable reputational capital on a scientist's research reports, promote a researcher's impartiality at the outset of investigation rather than committing her to a particular view *a priori*. As a result, investigation can begin with an open mind, without dread of any particular kind of data. Even if a scientist expects to find a particular result, it is deemed dishonest and unethical to ignore data that is unexpected. Moreover, some of the most exciting discoveries are made when experimental results counter an apparently well grounded hypothesis. Publicly funded academic science does much to avoid the "hired gun" problem of adversarial litigation, though corporate funding and patent interests may make it seem acceptable for a scientist to function more like a corporate team player than a disinterested researcher, resulting in the private capture of independent academic research efforts.[68]

F. WHAT LAWYERS NEED TO KNOW ABOUT SCIENTIFIC RHETORIC

Objectivity is an ideal that is never realized in even the best science, not only because science is not an agentless process, but also because experimental data do not speak for themselves. People with subject-positions interpret them, and

68. *See, e.g.*, *An Interview with Helen Longino*, THE DUALIST UNDERGRADUATE J., Sept. 2003, at 2–3, *available at* http://philosophy.stanford.edu/apps/stanfordphilosophy/files/wysiwyg_images/longino.pdf.

make stories out of them. Thus, in asking and answering, science retains a residue of subjectivity that even rigorous application of the scientific method cannot wash out. Cosmetic norms of storytelling in science are designed to draw the audience's attention away from these blemishes. Scientific data is made to appear to speak for itself: research communications are made in passive voice, and any subject pronoun should be in the plural if it must appear at all. Thus, in striving to be and to appear to be objective, scientists must disavow their own agency, their own participation in the processes of scientific discovery and technological development. This practice is a rhetorical move rather than the result of actual attainment of a truly objective perspective; accordingly, a critic has called it the "God-trick."[69]

When they speak *as* scientists, responsible scientists will be extremely reluctant to speak in absolute terms or to claim that their data "proves" anything, because of the open-ended reassessment of research results that is intrinsic to the scientific method. Lawyers need to know that in the language of scientific communications, data *suggest* interpretations, interpretations or models are *consistent with* findings, and further study is called for. Scientists agree in a qualified way: to the best of their knowledge. An unqualified statement that does not reflect intellectual care, but instead sounds certain, raises flags in the mind of a scientist—including that of an opposing expert witness.

For example, scientists are often asked to assess the sustainability of natural resources and report their results to the public. In 1863 Congress chartered the National Academy of Sciences[70] to "investigate, examine, experiment, and report on any subject of science or art" when requested by the U.S. government.[71] In its report on the condition of the Bering Sea Ecosystem, this is how the National Research Council expressed its assessment:

> It *seems reasonable to suggest* that the dramatic increase in the abundance of pollock . . . *may have been in some way linked* to overexploitation and reduction of these [predatory] populations.[72]

This report reflected a consensus opinion developed over decades by numerous independent investigators working in a variety of disciplines (such as marine biology, ecosystem science, and oceanography). It reflected a basic principle of ecosystem science: that the abundance of a particular species of fish in the North Pacific ecosystem was due to elimination of its predators by fishing. Nonetheless, this conclusion is very carefully worded because—being science—it is always

69. DONNA J. HARAWAY, *Situated Knowledges: The Science Question in Feminism and the Privilege of Partial Perspective*, *in* SIMIANS, CYBORGS, AND WOMEN 183 (1991).

70. 36 U.S.C. § 150301 (2012). The National Academies grew to include the National Research Council in 1916.

71. *Id.* § 150303.

72. NATIONAL RESEARCH COUNCIL, THE BERING SEA ECOSYSTEM 232 (1996) (emphasis added).

only a tentative and uncertain "conclusion," a pausing-point in scientific progress. This is much like talking about well established scientific research results as theory.[73] Skepticism and rigor attend the strongest science. While it is appropriate to acknowledge uncertainty, lawyers need to know that this careful terminology reflects the skepticism of the scientist more than the (lack of) utility or empirical reliability of the reported research results.

Thus, despite the consistent picture of the declining health of an ecosystem methodically assembled over decades of meticulous research by various independent groups of scientists, and despite the ease of showing fundamental flaws in the work of the few dissenting scientists, in the courtroom the situation can look more balanced to the legal fact-finder.[74] Each side has its own scientists, and people who are not scientists with relevant specialized expertise are left confused by the scientific aspects of the case after hearing their testimony, because their picture of this carefully built consensus has been distorted to appear balanced.

III. LEGAL NORMS UNDER WHICH THE SCIENTIFIC EXPERT WITNESS TESTIFIES

This Part compares the scientific and legal norms that bear upon the expert witness who is about to testify, examining how the goals of science and law are related, how procedural integrity affects scientific and legal fact-finding, and the similarities and differences between objectivity claiming and "facts" in each profession.

A. LAW AS A MECHANISM FOR DISPUTE RESOLUTION

Law as an institution has developed from the need for social order. Etymologically, "law" derives from words meaning "something laid or fixed."[75] This desire for a fixed starting point, for something certain that can be widely known and relied upon as a foundation for creating order in and gaining control over the conditions of our day-to-day existence, urges the development of law.[76] When

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73. *See supra* Part II.D.1.

74. SCHNEIDER, *supra* note 45, at 217–18:

> To quote a hundred-scientist assessment in one sentence and then "balance" the story by giving equal space and credibility to one of a handful of contrarian scientists who represent a tiny minority of knowledgeable opinions is irresponsible journalism in my opinion. Such false balance projects a distortion of the mainstream knowledge base of the scientific community because it represents all opinions as somehow being equally credible, even though thousands of scientists have worked for years to sort out the likely from the unlikely—and we're still doing that because science is never 100 percent sure of anything . . .

(quoting Stephen Schneider, *Twisted Revision*, WASH. POST (Jan. 9, 1998)).

75. OXFORD ENGLISH DICTIONARY ONLINE, LAW, N.1, ETYMOLOGY (2d ed. 1989).

76. *See, e.g.*, Roscoe Pound, *Law and the Science of Law in Recent Theories*, 43 YALE L.J. 525, 536 (1934) ("As the strict law gave us rule and form as a means to certainty and uniformity in the granting and applying of legal remedies, as equity and natural law gave us the idea of making conduct certain by insistence on reason and

various members of a community have interests in persuading the community to allocate its resources in different and conflicting ways, the community can find it impossible to serve those various interests, and be caught in a state of impasse that prevents it from serving anyone. An interest in dispute resolution that would enable social progress in some direction calls for the establishment of common ground that can be used as a basis for negotiation and development. An orderly society needs mechanisms for settling disputes, for authoritative decisionmaking to coordinate and guide its activities. Thus, the purpose of law is not epistemological *per se*,[77] even though a blindly fashioned social order is unlikely to inspire compliance and public confidence. Social ordering that is thought to reflect reality—or at least, to be empirically informed—is more likely to be accepted, thought legitimate, have authority, and be regarded as truly our best effort at producing justice.

Accordingly, the institutional goals of law and science are distinct but related: to have the highest likelihood of producing a just result, the legal fact-finder requires the most accurate information about the situation in question.[78] In this sense, the goal of science is foundational to that of law. Science that reflects scientific professionalism is the best of our knowledge, and legal professionals need this knowledge to make our best efforts at justice.

B. LAW GRAPPLES WITH SUBJECTIVITY

We look to science and to law for certainty. Yet both science and law are rife with uncertainty: that is why law is a thriving profession, and why scientists always have more research to do. As long as we have incomplete information, we will have uncertainty, and without omniscience, we will always have incomplete information. What makes science and law special are their procedural mechanisms for managing uncertainty, which give each their greatest ability to reach towards truth and justice.

Just as scientific procedures are calculated to neutralize subjectivity, legal procedures grapple with subjectivity as well. One of the homologies between law and science is their fundamental reliance on procedures that place a variety of checks on individual and collective biases. The Federal Rules of Evidence reveal

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good faith, the nineteenth century gave us the system of individual legal rights as a means toward security, an end toward which the other means had been reaching.").

77. Newman, *supra* note 1, at 423:

> Judges must resolve disputes when they reach us, whatever the state of the science. That the next case may be decided differently does not mean that the law is unconcerned with scientific truth; it means only that the law is applied in accordance with the evidence of the moment. Thus the rigors of scientific truth are subordinated to the practicalities of dispute resolution.

78. *Id.* at 419 ("[J]udges have a special obligation to bridge that gap [between law and science], working with scientists for mutual understanding, so that differences that today can distort the search for truth may instead serve to guide it.").

the extent to which evidentialism and reliabilism are at work in the production of legal knowledge.[79] Evidentialism would suggest that the belief of the legal fact-finder is justified to the extent that it coherently accounts for the evidence before him: the less evidence is accounted for by the belief, the less justified it is, and the less legitimate a basis for legal decisionmaking. The low relevance standard of the rules[80] suggests a commitment to evidentialism—a preference for all pertinent evidence to reach the fact-finder and inform his decision. However, the rest of the rules and other laws prevent relevant evidence from reaching the fact-finder.[81] Even after these rules have filtered the relevant evidence, there is little to require that the fact-finder account for the entire constellation of evidentiary points in his decision. Well crafted judicial opinions will address the evidence favoring and disfavoring their holdings, though some evidence may simply be ignored. Juries need not account for their fact-finding processes at all, so we have little data showing the extent to which evidentialism is at work in their decisionmaking.[82]

Some of these rules maintain truth-seeking as a primary goal. For instance, the hearsay rules exclude evidence on the basis of reliabilism. Reliabilism would suggest that the belief of the legal fact-finder is justified to the extent that it results from reliable cognitive processes. Hearsay, which consists of an out-of-court statement reported for its truth by a party,[83] is deemed less reliable than a statement made by the witness herself while under oath and subject to cross-examination. Therefore, the fact-finder is not to consider hearsay—unless an exception suggesting its reliability or the fact-finder's greater need to hear the evidence allows.[84] Of course, the fact-finder's heightened need does not increase the reliability of this kind of evidence; to the extent that this basis for hearsay exception reflects a truth-seeking goal, the principle at work is closer to evidentialism in that it reveals concern that the fact-finder have sufficient evidence to support his decision. Justification for the fact-finder's belief depends on the quantity of evidence for which it accounts—an evidentialist concern—and

79. *See supra* Part II.B.2.

80. FED. R. EVID. 401 ("Evidence is relevant if: (a) it has any tendency to make a fact more or less probable than it would be without the evidence; and (b) the fact is of consequence in determining the action.").

81. FED. R. EVID. 402 ("Relevant evidence is admissible *unless* any of the following provides otherwise: the United States Constitution; a federal statute; these rules; or other rules prescribed by the Supreme Court." (emphasis added)).

82. Yet the court may assume that the jury takes an evidentialist approach. *See, e.g.*, Kimberly A. Moore, *Judges, Juries, and Patent Cases—An Empirical Peek Inside the Black Box*, 99 MICH. L. REV. 365, 401 (2000) (presenting an empirical study supporting inferences about jury decisionmaking, but of course lacking observations of the process of juries' fact-finding) ("The Federal Circuit reviews black box jury verdicts by presuming that the jury found all facts in the record in support of the verdict it chose.").

83. FED. R. EVID. 801(c) ("'Hearsay' means a statement that: (1) the declarant does not make while testifying at the current trial or hearing; and (2) a party offers in evidence to prove the truth of the matter asserted in the statement.").

84. FED. R. EVID. 801, 803, 804, 807.

the quality of the evidence on which it is based—a reliabilist concern.

Yet these principles of justification for legal decisions do not provide the only legal basis for excluding evidence. The rules prevent some relevant and reliable evidence from reaching the fact-finder for reasons unrelated to truth-seeking, so that these unrelated reasons override the truth-seeking functions of legal knowledge production. For example, other social values such as promoting the purchase of liability insurance[85] or the privacy of marriage[86] limit the fact-finder's ability to consider all of the available data.

If the integrity of these procedures is undermined, then our reach towards truth and justice is misdirected. To those who cannot observe or interpret how the procedures are carried out, a scientific or judicial opinion generated by compromised procedures may still bear the imprimatur of science or law, though it will not deserve such status. This is why professional ethics are of central practical importance in science and law. Without the scientist's and the lawyer's professional commitment to procedural integrity, facts with the highest epistemological quality that we can achieve are not found, and our best efforts at justice fall even shorter than they might.

Because the result of any decisionmaking process depends on the premises from which the process begins and the method applied to reach the result, collective efforts to establish fixed points, and methods for identifying and developing them, have political dimensions. An individual with a reputational, economic, psychological, or other interest in obtaining a particular outcome from a decision that affects the community may begin her argument by assuming that result as a premise, or may choose an argumentative method that favors her desired outcome, or both. Commitment to a specific predetermined answer is antithetical to science. The scientist is professionally committed to analyzing research results with an open mind, and to exploring creatively the space of supportable interpretations, discussing all of its most powerful options.

Epistemic communities influenced by the Enlightenment have tended to disfavor theological techniques of argument, privileging modes of argument and decisionmaking that are more like those of science in that objectivity is sought and appeals to empiricism and logic function as appeals to reasonable or objective bases for dispute resolution. Lawyers need to be aware that the authority of our legal system is enhanced when it can make strong objectivity-claims by demonstrating that its decisions are rooted in an objective, or at least agnostic, process.

C. CLAIMING OBJECTIVITY

Thus, our law depends on the idea that there are objective states of justice and

85. FED. R. EVID. 411.
86. A common-law privilege; FED. R. EVID. 501 recognizes common-law privileges.

equity that can be manifest in social ordering,[87] and that a just and equitable state is accessible through the development and application of law. The search for a common ground that can serve as a foundation for social decisionmaking is thus formally the search for objectivity, for a perspective that is independent of political interests, and realistically—especially when a jury is involved—for a perspective that accurately reflects, or corresponds to, the political interests and values of the relevant community (for example, in federal courts the jury must provide complete consensus[88]). The search for objectivity in law was manifest both in the efforts of classical legal positivists to separate law from politics and in those of legal realists to turn to sociology to inform the development of the law.[89]

1. The Influence of Science on Legal Objectivity-Claiming

Legal positivists like Justice Oliver Wendell Holmes believed in the objectivity-claims of science, and tried to model legal procedure on scientific reasoning procedures in order to strengthen legal objectivity-claims and the authority associated therewith. In *The Path of the Law*, Holmes describes law in ways that emphasize its ties to science, noting a reductionistic mechanism for "eliminating . . . all the dramatic elements . . . and retaining only the facts of legal import" in a case, thus disfavoring emotional argument and favorably distinguishing legal reasoning.[90] Science similarly manifests a separation of emotion from dispassionate reason, favoring the latter mode of persuasion or argument. Borrowing a metaphor from physics, Holmes also describes the study of law as the study of predicting how cases will be disposed "by the incidence of the public force through the instrumentality of the courts."[91] Similarly, scientists prize the predictive power of a scientific model as an indication of its truth (of its correspondence to objective reality).

Legal realists like future Supreme Court Justice Louis D. Brandeis looked to the objectivity-claims of science not as a source of procedure but as a source of substantive evidence. In an attempt to use science to strengthen the objectivity-claims of his legal arguments, Brandeis and Josephine Goldmark submitted a brief relying on extensive empirical data to argue that an Oregon statute limiting women's work-hours in certain settings should be upheld.[92] Even in the *Lochner*[93] era (in which the U.S. Supreme Court struck down many state statutes that

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87. U.S. CONST., pmbl.

88. FED. R. CIV. P. 48(b) ("[T]he verdict must be unanimous and must be returned by a jury of at least 6 members").

89. MORTON J. HORWITZ, THE TRANSFORMATION OF AMERICAN LAW 1870–1960, 193–212 (1992).

90. Oliver Wendell Homes, *The Path of the Law*, *in* AMERICAN LEGAL REALISM 15 (William W. Fisher III, Morton J. Horwitz, & Thomas Reed, eds.) (1993).

91. *Id.*

92. Louis D. Brandeis & Josephine Goldmark, *Brief for Defendant in Error*, *Muller v. Oregon*, 208 U.S. 412 (1908).

93. Lochner v. New York, 198 U.S. 45 (1905).

were protective of laborers for unconstitutionally interfering with private contracts), Brandeis prevailed, and the practice of bringing to courts arguments based on social science caught on.

2. Objectivity-Claiming in Textual Interpretation

Although across the spectrum of jurisprudence judges and legal scholars have found resonances between law and science, these homologies do not map neatly from one realm into the other. Law is not science in the modern sense, in that the questions before courts and legislatures are not scientific questions that can be answered through rigorous application of the scientific method. The legal profession has retained exegetic means for claiming authority that resemble those of theological argument, while supplementing these with calls to scientific authority.

Once a constitution is established through the consensus of originary legal authorities, legal authority passes to that text. The constitution is then treated as though it were a religious text in that it is given supreme authority, while methods of interpretation and implementation may be contested. Objectivity claims then become claims to a posited objective meaning of the text of the constitution.

In the United States, the authors who created the state by means of written instruments are called the "founding fathers." These instruments include the Declaration of Independence, which separated the colonies from the imperial seat so that a new state could form, and the Constitution, which gave the new state its form. The Constitution is recognized as the state's supreme legal authority. However, the judiciary interprets the Constitution through litigation, the legislature implements it through a process of lobbying, debate, and negotiation, and the judiciary and legislature participate in a slow-moving institutional dialogue over the realization of the text's message in an evolving society that has always already changed again.

A more pragmatic, derivative kind of objectivity-claiming is discernible in our system of common law. Where the Constitution and statutes do not speak directly, judges are entrusted with the power to resolve particular cases in ways consistent with the legal and equitable principles embraced by the Constitution.[94] The need for dispute resolution enables the development of judge-made law, and the Constitution and procedural statutes provide the methods practiced by the judges in their lawmaking. This method is the counterpart of the scientific method practiced by scientists, who, as fact-finders, are the judges' analogs.[95] Uniformity of common law procedure, binding precedent, *res judicata*, *stare decisis*, and appellate review all work together to wash the subjective perspectives of individual downstream judges out of the judicial process, though the opinions of

94. Freeland, *What Is a Lawyer?*, *supra* note 46, at 448.
95. *See supra* Part II.E.

judges past will have settled into law with all their imperfections. Judicial authority increases with the strength of the objectivity-claims of the judicial decisionmaking process.

Objectivity claims invoking textual and scientific authority are also evident in legislative processes, although legislation is a very openly political process. In contrast with scientific rhetoric, political rhetoric is often designed to sound definitive, and words are often deliberately crafted to "sell" political positions, whether or not they correspond accurately to the reality to which they purport to respond.

Textual exegesis is inherently political, in that language is inherently ambiguous and the play in a single word—let alone a string of words—requires a subjective interpreter to choose from its possible meanings. A strain of reliabilism can be found in the law, in that an interpreter's adherence to accepted legal procedures is vital to the claim to objectivity, and hence to the authority, legitimacy, and prestige of the legal institution. Procedures can be seen as legitimating rituals. Following them constrains the interpretive freedom of the subjects construing and applying the law, and thus confers some credibility on the results obtained through their use.

3. The Effect of the Need for Closure on Legal Objectivity-Claiming

Because it must function to resolve disputes and promote settled social ordering, repose—rather than provisionality—is valued in law. Judges thus attempt to craft decisions that will settle disputes with finality, thereby to articulate laws that can be relied upon by citizens of the jurisdictional community. While the appellate process of science is infinite in principle, it is a truism that the U.S. Supreme Court's decisions are right because they are final, and not final because they are right.[96] Efficiency concerns ultimately curtail the search for truth in the workings of our legal institutions.

While the primary purpose of the process of adversarial litigation before a court is dispute resolution, the process is simultaneously designed to settle disputes justly.[97] For instance, due process must be afforded to insure that litigants are treated equally, and therefore justly, by the legal system. Because a decision is more likely to be considered just if it is perceived to be based on a unified, complete, true-seeming set of facts, adversarial litigation has an essential truth-seeking function.[98] The adversary system is structured so that disputes are typically argued and settled by officers of the court whose first duty is to protect

96. Brown v. Allen, 344 U.S. 443, 540 (1953) (Jackson, J., concurring) ("There is no doubt that if there were a super-Supreme Court, a substantial proportion of our reversals of state courts would also be reversed. We are not final because we are infallible, but we are infallible only because we are final.").

97. FED. R. CIV. P. 1.

98. This function is manifest in that witnesses testifying to inform the legal fact-finder must swear an oath to tell the truth, the whole truth, and nothing but the truth. *See supra* note 6.

the integrity of the legal process—for instance, by not misleading the fact-finder.[99] The form of a lawsuit requires a reductionistic approach, so that disputes consisting of multiple messy disagreements between multiple parties are cast as bilateral disputes on well-pleaded issues for which there is a remedy at law. Each side has an advocate, whose responsibility is to argue zealously (but not overzealously[100]) for the interests of the party she represents, without violating her ethical responsibilities to the court.

In principle, if each side were equally well represented, its best arguments would reach the judge in the most persuasive form that is honestly supportable by their evidence. The judge is the supreme legal expert in the courtroom, who balances these best arguments of both sides and decides how best to settle the dispute legally and justly. The decision is expressed in the judge's legal opinion, which can be appealed to a higher judge in the hierarchy of courts. Appeals can rise only as high as the U.S. Supreme Court, whose decisions bind all lower courts. By contrast, appeals in science can be tried by any scientist, and the appeals process is infinite. Accordingly, the strength of objectivity claims in science can increase indefinitely, while the development of the strength of objectivity claims in law is truncated early and often.

4. The Nature of a Legal Fact

Cases in law are analogous to experiments in science, in that each provides an opportunity for the authoritative voice to speak, for the authoritative institution to look for, identify, and examine patterns in its field, and to decide which patterns matter and ought to matter. Each presents an opportunity to categorize, to identify and create order. However, cases and scientific experiments differ importantly. While some appellate judges have the discretion to select which cases to hear, for the most part judges cannot directly control the circumstances of their cases. Scientists strive for experimental control, rely on it in developing their opinions, and keep track of the assumptions upon which their opinions are contingent so that later opinions might be better informed.

In court, the fact-"finder" determines from a constellation of admitted evidence the facts on which the judge's opinion is based. Legal evidence epistemologically resembles scientific data, in that it consists of bits of information that are typically an incomplete reflection of the reality in question. The correspondence theory of truth is at work in the courtroom as well as in the laboratory. Like scientific data, these bits of information must be produced by an accepted and rigorously applied procedure,[101] and they will be interpreted in light of each other and of the theories

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99. MODEL RULES OF PROF'L. CONDUCT R. 3.3 (2010); *see also* Freeland, *What Is a Lawyer?*, *supra* note 46, at 449.

100. Freeland, *What Is a Lawyer?*, *supra* note 46, at 453–54.

101. For example, by the application of the Federal Rules of Evidence.

to which they are relevant. Methods for interpreting legal facts are not specified (and when the fact-finder is the jury, they remain invisible to the legal decisionmaking process). Neither evidentialism nor reliabilism necessarily, comprehensively characterizes legal fact-finding, and legal facts carry a greater likelihood of inaccuracy and arbitrariness than do scientific research results.

In turn, common law is built up from legal facts like a multidimensional histogram or scatter-plot. Each material fact is a coordinate on an axis representing a variable; the combination of variables is ruled on by the judge, who attaches to it a legal decision. A constellation of all of the various facts, which serves as the input for a judicial decisionmaking function, will yield different results from that function depending on the court in which it is calculated and the judge who calculates it. This occurs because different judges and juries weigh each of the facts differently, both in themselves and depending on their combination with other facts. Different fact-finders also decide differently whether a particular fact will matter at all in the decision. Different judges also have different precedents to apply, depending on the courts in which they sit. Even within the same court, different judges identify, construe, and are persuaded by different plausible precedents differently. Thus, even if *facts* were identical from case to case, the plot of outcomes from identical cases would still show a good deal of scatter. Since the judicial decisionmaking function of the common law is offered very nonuniform input, and is subject to very scattered output even when legal procedures are applied by judges in good faith, law can seem incoherent and unpredictable.

D. LEGAL RHETORIC

The voice of legal authority is unified before its utterances are cited. The voice of the law as legislation is unitary, speaking in the words of a statute. A statute's legislative history might be examined to aid in statutory interpretation, but technically holds no authority. Thus, the multiple voices of legislators in debate, informed by the multitudinous voices of lobbyists and voters, are reduced to the single voice of the statute before their utterances are treated as law. Multiple subjectivities are reified into one text that is the speech of no one person, in an incompletely traceable way. Similarly, judicial construction of a statute is guided by the voices first of the statutory language, then of binding precedent, then of persuasive opinions from sister courts, and then of judges' individual discretion to serve equity and justice.

In common law, binding precedent on a point is articulated in an official reported opinion, and followed by lower courts. A lower court may elaborate on the received precedent, if it can identify in good faith a material distinction between the facts to which the precedent applies and the facts before it. Its ruling can be appealed to the higher court that set the precedent, and that court can thus exert some control over the elaboration of its rules. Nonetheless, the subjective perspective of the lower court may be little affected.

Note that "the court" is often a person, and is otherwise a small group of people, each of whom may write his own opinion, his own law. Some courts have begun to refer to themselves as "I," challenging the conventional God-trick style in which some judges have written their opinions: even when speaking of himself, the opining judge may refer to himself as "we" or "this court," if he refers to himself at all. This rhetorical move is made in science as well, and may have been imported therefrom for objectivity-claiming purposes: use of the term "this court" unmoors the law-making institution from the individuality of the opining judge. The term is most appropriately used when the opining judge is speaking for a group, such as a majority of judges *en banc*, or a collection of judges who have sat in the court over historical time, as in, "This court in 1888 held that . . . ." Such distinctions are not often reflected in a court's language, which often forgoes the "I" in attempting to signal its objectivity, and thus its claim to authority and legitimacy. However, this framing does not eradicate the subjective perspective of the court.

Legal expression that adheres to a linear, narrative format is more readily recognized as being well reasoned, and is more strongly associated with objectivity. Legal reasoning that reflects linear thinking tends to signal a claim to objectivity, and thus its author's claim to authority and legitimacy. This form of expression is reminiscent of mathematical reasoning and scientific exposition, and by association tends to endow its content with the ring of truth.

IV. THE SITUATION OF THE EXPERT WITNESS: THE DOUBLE ETHICAL BIND

> *The time has ripened for mutual understanding, after so many years of unproductive tension—in the courtroom as in society at large.*[102]

The scientific expert witness finds herself caught in the middle of two normative systems that expect her to speak in different ways. What exactly is the expert witness supposed to do? This Part focuses on the procedural and epistemic tensions surrounding her performance as she attempts to speak across the boundary from science into law.

A. PROCEDURAL TENSIONS WITH RESPECT TO UNCERTAINTY

As described above, procedural approaches to objectivity-claiming in law and science diverge in important respects. In incorporating scientific authority into the legal process, lawyers must manage the tension between the provisionality of science and the legal system's need for repose. Law should be settled so that its subjects can take notice of it, ordering their affairs and relying on the social order

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102. Newman, *supra* note 1, at 420.

that is built upon it. However, law should also be flexible, in that to serve justice it must adapt to changing social conditions as political and socioeconomic conditions evolve. Judicial decisionmaking processes allow for both sedimentation and upheaval, but sedimentation and the formation of new bedrock is ultimately favored. The legitimacy of legal decisionmaking depends on closure.[103]

Lawyers must bear in mind that in scientific cultures, openness is valued in part because it prevents dogma from solidifying. A tradition of skepticism that endures over large timescales helps to mitigate collective bias that comes not from a particular researcher but from the more general cultural context of a given place and time, and hopefully prevents it from remaining in science indefinitely. Thus, while the sedimentation of scientific knowledge is desirable, the scientist's primary concern is with preventing flaws from settling into the precipitating knowledge, so that the bedrock will be less likely to crack as more new knowledge settles upon it. The positivistic hope of perfection makes the development of science resemble a crystallization process. Conditions are carefully controlled so that the precipitating knowledge will coalesce in an orderly way, so that its totality reveals something about its particulate structure. If a flaw is detected, ideally the flaw is studied, the layers based on it are redissolved, and crystallization is re-attempted. In contrast, common law maintains itself by looking backward more than forward, so that if flaws fall into the sediment, they fossilize. The law will not be undone until the bedrock cracks.

Law and science treat uncertainty differently. Law, deriving authority from closure, strives to eliminate uncertainty, and will produce a decision regardless of it. In contrast, science values uncertainty as information for directing inquiry, and will attempt to account for it but not to eliminate it by fiat. Judicial decisionmaking based on contemporary science at best fossilizes the scientific consensus of the time at which a decision is made; considering later-available scientific evidence is undesired, because it may disturb the repose of the law. However, justice may be better served if sedimentation of the law around science that has been superseded were disrupted and resettled around our new best evidence.

An understanding of the scientist's professional commitment to discerning uncertainties and alerting colleagues to their presence and nature can help the lawyer to explain to the scientist the differences between the scientist's normal professional speech and her discursive situation in court: she is not reporting material for other scientists to pursue, but informing the public of her best guess at the state of physical reality. The overriding goal is to provide an account of reality that, to the best of her knowledge at the moment, corresponds accurately to it, and not to invite further research. If she addresses the legal fact-finder as

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103. "[T]he balance that is struck by [the] Rules of Evidence [is] designed not for the exhaustive search for cosmic understanding but for the particularized resolution of legal disputes." Daubert v. Merrell Dow Pharms., Inc., 509 U.S. 579, 597 (1993). This general idea is also discussed in Ellen E. Deason, *Incompatible Versions of Authority in Law and Science*, 13 SOCIAL EPISTEMOLOGY 147 (1999).

though he were a scientific audience, he will likely misunderstand her message. Instead, she must translate her report to fit the discursive task—not only to simplify the unfamiliar substance of science, but also to explain how scientists work and speak. Although many lawyers may be intimidated by the prospect of working with science, lawyers are well equipped to solve problems that are ultimately rhetorical: problems of cross-cultural differences in codes and forms of communication.[104]

B. EPISTEMIC TENSIONS WITH RESPECT TO FACTS

Evidence is treated differently in law and science. "Evidence" is defined as "[t]he quality or condition of being evident," "manifestation; display," "[a]n appearance from which inferences may be drawn; an indication, mark, sign, token, trace," and "*[g]round for belief*; testimony or facts tending to prove or disprove any conclusion."[105] In law, not every bit of data about a case will be treated as evidence by a court. Procedures and rules exist for admitting data into evidence, and the fact-finder is precluded from informing itself with data that is not in evidence. For example, since a person's testimony alone can matter as a fact, there are elaborate rules for identifying hearsay, and for admitting hearsay when the court has not much else on which to base its decision.

In science, the scientific method is used in experimental design, thereby serving as an evidentiary gatekeeper as do the legal rules of procedure and evidence. The experiment is analogous to a legal question, but *all* of the data collected in an experiment counts as evidence. Like the judge, the scientist examining the data may choose to weigh some results more heavily than others, deciding which will matter as fact and which will not.

"Fact" is defined primarily as "a thing done or performed."[106] This definition is apt regarding both scientific and legal facts. A fact-"finder" does not merely discover a fact as such, but chooses to look at certain data and to see in certain ways in conducting discovery. Thus, the fact-finder exercises decisionmaking power that determines what will constitute a fact—that sifts what will matter from what will become invisible to the legal or to the scientific process. Sorting the legal from what does not matter under the law is boundary work that requires legal expertise. Similarly, sorting science from non-science is boundary work that requires scientific expertise.

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104. Some of the problems that arise in speaking science to law also arise across other disciplines. For illuminating examples, see MYRA H. STROBER, INTERDISCIPLINARY CONVERSATIONS: CHALLENGING HABITS OF THOUGHT (2011).

105. OXFORD ENGLISH DICTIONARY ONLINE, EVIDENCE, N., I.1.A, I.2, II.3.A, II.5.A (2d ed. 1989) (emphasis added). Definition II.5.A specifically gives rise to our legal usage, and demonstrates the work of the epistemological view of truth as justified belief in this context.

106. OXFORD ENGLISH DICTIONARY ONLINE, FACT, N., 1 (2d ed. 1989).

1. Whose Boundary Work Should It Be?

The classic article, *Science and Trans-Science*,[107] by Alvin Weinberg, can be understood as an analysis of boundary work in science. Weinberg defines as "trans-scientific" those questions of fact that could be asked of science but cannot be answered by it.[108] The most pertinent type of trans-scientific question he described is one that "science is inadequate [to answer] simply because the issues themselves involve moral and aesthetic judgments: they deal not with what is true but rather with what is valuable."[109] Weinberg, a nuclear physicist, viewed adversary procedures as those appropriate to trans-scientific questions, whereas scientific questions should be addressed using scientific procedures. The participation of non-scientists—those who do not understand the language and norms of science—in scientific processes would confuse and distort their results. However, having to respond to the public can helpfully force scientists to perform the necessary boundary work to inform the adversarial process of the scope of scientific authority.[110] A scientist "must establish what the limits of scientific fact really are, where science ends and trans-science begins."[111]

And yet, the case of *Daubert v. Merrell Dow* has identified and established the judge as the keeper of the gate through which scientific facts may or may not be admitted as legal evidence.[112] The *Daubert* Court held that Federal Rule of Evidence 702 superseded the common law standard for the admissibility of scientific expert testimony, the *Frye* test which provided that expert opinion testimony is only admissible if it is based on techniques that are generally accepted by a relevant scientific community.[113] The *Daubert* standard for admissibility was designed to be more permissive by rendering the *Frye* test non-mandatory and only one among several guidelines that the court may use in the boundary work of sifting science from non-science. Under *Daubert*, testimony must be based on techniques that are scientifically valid, whether or not they have gained general acceptance.[114] However, the *Daubert* standard as applied instead can raise the bar for admissibility, since a judge may, when in doubt, keep science out.[115] This promotes the ability of lawyers to get evidence

107. Alvin M. Weinberg, *Science and Trans-Science*, 10 MINERVA 209 (1972).

108. *Id*. at 209.

109. *Id*. at 213.

110. *Id*. at 219 ("[E]xperts consider public intrusion into the scientific parts of the debate by the uninitiated as obfuscatory; on the other hand, the public's involvement helps force a delineation between science and trans-science.").

111. *Id*. at 216.

112. Daubert v. Merrell Dow Pharms., Inc., 509 U.S. 579 (1993).

113. Frye v. United States, 293 F. 1013 (1923).

114. *Daubert*, 509 U.S. at 590.

115. Haack, *supra* note 27, at 990 ("[W]hile the ostensible intent of the Daubert ruling was to relax the 'austere standard' of the older *Frye* rule in accordance with FRE 702 . . . it is far from clear that this has really been its effect.").

excluded by exaggerating the articulated uncertainties that characterize rigorous science.

Under *Daubert* the first step of the judge's admissibility analysis is to determine whether the testimony is scientific knowledge.[116] Therefore, judges in particular need to understand what scientific knowledge is.[117] The five exemplary factors identified by the *Daubert* Court for consideration in determining whether testimony is scientific knowledge reflect some understanding of the characteristics of knowledge that has been created through the application of the scientific method: whether the theory has been tested, whether the theory has been subjected to peer review, the known or potential rate of error resulting from the theory's application (this factor constitutes an implicit acknowledgment of a kind of scientific uncertainty), the existence and maintenance of standards controlling the application of the theory, and the general acceptance of the theory in a relevant scientific community (the *Frye* test).[118] The judge's assessment should focus on the procedures used to obtain the content of the testimony, and not on the substance of the testimony itself.[119] This focus on procedure is reminiscent of the principle underlying the Fifth Amendment Due Process Clause: that one might separate law from politics by applying decisionmaking means uniformly, rather than making decisions based on a known or desired outcome. In theory, this focus on procedure allows for true agnosticism on the part of the decisionmaker: blind justice applies her balance uniformly, and the facts of the case speak for themselves, tipping the scales one way or the other. But testimony is evidence spoken by witnesses, and expert witnesses may have the strongest effects on the jury[120] to the extent that they are perceived to present science—evidence with the strongest claims to objectivity.

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116. *Daubert*, 509 U.S. at 590. The second step is to determine whether the testimony will assist the trier of fact. *Id.* at 591.

117. Newman, *supra* note 1, at 420:

> [J]udges should, and can, learn to meet the scientists on their own ground. Judges should, and can, learn enough about science and its methodologies to bring independent judgment to the resolution of disputes. With judicial appreciation of how science is done and is brought to practical application, with judicial understanding of scientific certainty, the just resolution of disputes that turn on questions of science and technology is an attainable goal.

118. *Daubert*, 509 U.S. at 593–94. I have held close to the wording of *Daubert*, but used the term "theory" to encompass techniques or methods, since these only exist in the application of theory.

119. *Id.* at 595.

120. If expert witnesses are perceived to be credible their testimony can be very influential, though expert witnesses instead can be viewed as scientists who have been "bought" to support an argument regardless of whether the relevant science actually does. *See, e.g.*, Shari Seidman Diamond, *How Jurors Deal with Expert Testimony*, 16 J.L. & POL'Y 47, 53 (2007) (citations omitted) ("[S]urveys of jurors indicate that while jurors find expert testimony to be useful, they are also wary of experts. . . . . [C]ountervailing forces influence juror perceptions of expert testimony because the credibility of a communicator is influenced by the communicator's expertise and trustworthiness. The expectation of potential bias acts as a brake on the persuasiveness of an expert.").

The validity of scientific propositions, ranging from its robust "laws" to its most tentative hypotheses, must be determined by the judge.[121] Judges have expressed concern that their lack of scientific expertise leaves them unprepared to distinguish between scientific testimony that is or is not the result of proper application of the scientific method, properly framed.[122] Even where a judge is an expert with regard to the subject of scientific testimony, the judge may take the structure of the two-party adversarial litigation process for granted, and forget that the presentation of scientific expertise by both sides will likely give the jury or even the judge himself the impression that science is agnostic on the matter, or that scientific opinions are evenly divided when they actually clearly favor one side.

2. The Neutral's Expert Witness

Daubert has generated a burgeoning scholarly literature reflecting concerns with the feasibility and effectiveness of the judge's new epistemological role.[123] In an article on the problems with expert witness testimony, Jennifer Mnookin concludes that "so long as we have our adversarial system in much its present form, we are inevitably going to be stuck with approaches to expert evidence that are imperfect, conceptually unsatisfying, and awkward."[124] Mnookin usefully frames these entrenched problems in terms of partisanship (the expert witness's identification with one side in litigation) and the lack of legal fact-finders' epistemic competence with respect to science, and *Daubert* as a response to these

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121. *Daubert*, 509 U.S. at 593.

122. *See, e.g.*, *id.* at 600 (Rehnquist, J., dissenting in part):

> I defer to no one in my confidence in federal judges; but I am at a loss to know what is meant when it is said that the scientific status of a theory depends on its "falsifiability," and I suspect some of them will be, too.

also see Judge Kozinski's famous response to *Daubert* on remand:

> Our responsibility, then, unless we badly misread the Supreme Court's opinion, is to resolve disputes among respected, well-credentialed scientists about matters squarely within their expertise, in areas where there is no scientific consensus as to what is and what is not "good science," and occasionally to reject such expert testimony because it was not "derived by the scientific method." Mindful of our position in the hierarchy of the federal judiciary, we take a deep breath and proceed with this heady task.

Daubert v. Merrell Dow Pharms., 43 F.3d 1311, 1316 (9th Cir. 1995).

123. Search for "Daubert" in Lexis US Law Reviews and Journals yields over 3,000 hits in full text of an article, and 429 hits in the title (Sept. 8, 2012). *See, e.g.*, Susan Haack, *Disentangling Daubert: An Epistemological Study in Theory and Practice*, 5 J. OF PHIL., SCI. & L. (2005) (explaining the flawed epistemology of *Daubert*); David L. Faigman, et al., *Check Your Crystal Ball at the Courthouse Door, Please: Exploring The Past, Understanding the Present, and Worrying about the Future of Scientific Evidence*, 15 CARDOZO L. REV. 1799 (1994) (evaluating the admissibility of scientific evidence under *Daubert*).

124. Jennifer L. Mnookin, *Expert Evidence, Partisanship, and Epistemic Competence*, 73 BROOK. L. REV. 1009, 1033 (2008).

concerns.[125] When contemplating the use of Federal Rule of Evidence 706 to manage these problems, however, Mnookin sets aside two options that could help: the appointment of a single, neutral expert witness to articulate the scientific consensus, and when there is no such consensus, that of a diverse panel of neutral expert witnesses articulating legitimate scientific perspectives. Rule 706 allows the judge to appoint his own expert witnesses,[126] so that her testimony enters the fact-finder's consideration from a neutral position. Any party may question or cross-examine the court's experts,[127] and parties can call their own experts as well.[128]

Mnookin emphasizes that where scientific consensus has not formed, the court's calling a single expert witness to inform the fact-finder of the scientific perspective on a problem could create the illusion of a consensus view that would mislead the fact-finder.[129] Mnookin acknowledges that alternatively, the court-appointed expert witness could teach the fact-finder about the relevant science without taking sides, so that the fact-finder could better understand the partisan expert witnesses' testimony (to the extent his epistemic competence with science allows), and that "neutral [expert witnesses] could offer an effective and welcome check"[130] on the testimony of expert witnesses whose perspective has been distorted by partisan zeal. But even as she notes that court-appointed experts can "offer an adequate solution" to these problems when a scientific consensus does exist,[131] Mnookin nonetheless concludes that Rule 706 offers little hope.

Mnookin seems to confine her consideration of the use of court-appointed expert witnesses to the situation in which the court calls a single expert, or a panel of experts who will all present the same view even when scientific opinion is divided. However, Rule 706 could be used to present the diversity of scientific opinion to the legal fact-finder in a way that truly reflects this diversity, rather than framing it in terms of only two opposed views each of which favors one side. Independent scientific organizations like the National Academy of Sciences or the American Association for the Advancement of Science can identify scientists who could properly serve as court-appointed experts.[132] When the utility of a single, neutral expert witnesses articulating scientific consensus, and of a diverse panel of neutral expert witnesses articulating legitimate scientific perspectives

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125. *Id.* at 1019.
126. FED. R. EVID. 706(a).
127. FED. R. EVID. 706(b).
128. FED. R. EVID. 706(e).
129. Mnookin, *supra* note 124, at 1027.
130. *Id.* at 1026.
131. *Id.* at 1021–22.
132. The American Association for the Advancement of Science (AAAS) provides a program called "Court-Appointed Scientific Experts" (CASE) that has served this purpose for over a decade. AAAS, *CASE Experience*, *available at* http://www.aaas.org/spp/case/experience.htm (last visited Sept. 8, 2012).

are considered, the utility of Rule 706 becomes clear.[133]

The extent to which scientific uncertainty can be misconstrued and exploited in our legal system underscores the importance of Rule 706. When scientific caveats and recommendations are perceived to oppose a legal argument, arguments in response highlight scientific uncertainty, and may attack other aspects of science that do not signal a lack of rigor within scientific discourse.[134] Contrary assessments by a few scientists may be cited to demonstrate that the scientific community has failed to reach consensus around a single interpretation, and is thus divided.[135] It is argued that *legally* material uncertainty therefore exists, so that the cautionary recommendations of the majority of scientists more easily may be dismissed.

For example, in a lawsuit over the regulation of commercial activity to preserve environmental and economic sustainability, the commercial activity itself may contribute to uncertainty in the scientific assessment of its effects. An activity like deforestation might remove the flora and fauna and change the infrastructure of a given region, so that no untouched area can be referred to as a benchmark for what its ecosystem would look like in the absence of commercial intervention. Then, the best control for scientific experimentation is gone. The least-disturbed area therefore might be resorted to as a control, but this move tends to make any scientific assessments of the effects of commerce underestimate its impacts.

Trawling and the dispute over fishery management in the North Pacific

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133. *See, e.g.*, Stephen Breyer, *The Interdependence of Science and Law*, 82 JUDICATURE 24, 26–27 (1998); Newman, *supra* note 1, at 425–26 (citation omitted):

> Judges have made only limited usage of court-appointed experts, although they are authorized in the Federal Rules. Some judges explain that in their experience the presentation by adversary witnesses works well enough, citing the additional cost of another expert, accompanied by concern lest the decision-making role be transferred to the "neutral" expert. However, the recent use of a panel of highly qualified scientists in the breast-implant litigation has brought fresh support for the principle of providing expertise beyond that proffered by the parties, at least in areas of scientific complexity and conflicting evidence.

134. Newman, *supra* note 1, at 424:

> When we put scientific theory and evidence on the witness stand and subject them to cross-examination, by their very nature they are vulnerable to attack. The great strengths of scientific investigation become weaknesses in the courtroom, for inherent in the scientific method is the principle that any theory can be challenged . . . . Thus data are challenged in court that would not be reasonably challenged within the scientific community.

135. THE FEDERAL JUDICIAL CENTER, COURT-APPOINTED EXPERTS: DEFINING THE ROLE OF EXPERTS APPOINTED UNDER FEDERAL RULE OF EVIDENCE 706, 13 (1993) ("[T]otal disagreement in areas unfamiliar to the judge invited a general distrust of the experts."); *id.* at n.23 (offering examples of judicial explanations for using Rule 706, including "The main issue is whether the parties' experts are 'real' experts or simply 'hired guns,'" and, "[T]he 'swearing contests' that take place between expert witnesses are a national disgrace, and the 706 procedure may offer an alternative to sitting there and listening to it.").

provides such an example.[136] Trawling contributes to uncertainties in understanding aquatic ecosystems, because it drastically alters or removes baseline or control habitats and communities the condition of which could have been compared to that of those in trawled areas.[137] To trawl is to drag an enormous net along the ocean floor, pull the net out, throw back unwanted catch, and collect the desired or "targeted" species. Like other forms of deforestation, trawling adversely affects fauna not only directly, but also consequently from the destruction of the flora on which they depend for food and shelter. Plants that have been removed from the sea-bottom do not recover merely because they are thrown back into the water. The sea-bottom plants are the foundation of the ecosystem. As autotrophs, or generators of food, through their carbon-fixation and photosynthetic functions they support all of the higher trophic levels of the food web.

In addition, when undesired catch is thrown back into the ocean, aggressive species of aquatic hunting birds gain access to foods that they would not otherwise have been able to prey upon. These birds have been found to take over the nesting sites of other aquatic birds in the area, displacing them and threatening their survival. Thus, when sea-bottom plants are removed, the fundamental layers of the regional food webs and the region's three-dimensional system of habitats are destroyed. When an area has been trawled repeatedly over decades, there is no patch of undisturbed ecosystem that remains to indicate what the populations of its various species would have been in the absence of trawling. Ironically, these resultant uncertainties may then be cited to argue that trawling has little or no deleterious environmental impact. Even one neutral scientific expert could point this out to the fact-finder, and would not have any counterincentive against doing so.

Where there is a clear scientific consensus regarding the matter in question, the judge should also consider applying Federal Rule of Evidence 403 to ensure that the low probative value of an outlying scientific opinion not be substantially outweighed by the risk of juror confusion from the presentation of ostensibly equally accepted scientific opinions on both sides of the litigation. The concern about such juror confusion that judges have expressed in the context of applying Federal Rule of Evidence 706[138] is also relevant to judicial application of Rule 403. For example, if an expert were to report the scientific consensus based on the decades of multidisciplinary research discussed above[139] that the abundance of

136. Beth C. Bryant, *Adapting to Uncertainty: Law, Science, and Management in the Steller Sea Lion Controversy*, 28 STAN. ENVTL. L.J. 171 (2009).

137. COMMITTEE ON ECOSYSTEM EFFECTS OF FISHING, OCEAN STUDIES BOARD, NATIONAL RESEARCH COUNCIL, EFFECTS OF TRAWLING AND DREDGING ON SEAFLOOR HABITAT 18–29 (2002).

138. THE FEDERAL JUDICIAL CENTER, COURT-APPOINTED EXPERTS: DEFINING THE ROLE OF EXPERTS APPOINTED UNDER FEDERAL RULE OF EVIDENCE 706, 13 n.23 (1993) ("For example, in relating the reasons for appointing experts [under Rule 706], judges remarked: 'I discovered that experts in asbestos were so diverse in their opinions that they confused the jury'; . . . .").

139. *Supra* Part II.F.

pollock reflects the collapse of the ecosystem, it would be confusing to a jury to allow the opponent to present an expert witness who would report that the abundance of pollock reflects ecosystem health. The latter expert's testimony would be inconsistent with—and unreasonable in light of—the clear scientific consensus that the abundance exists because the species higher in the food web have been overfished, but the structure of the adversarial process would promote the appearance of a balanced scientific debate where there is none.

Similarly, in litigation over climate change, one expert witness would report the scientific consensus that human activities contribute to climate change, while the opponent might find an expert witness who would controvert the consensus. Because the consensus is clear,[140] presentation of the non-consensus view as equal and opposite could be so confusing to the jury as to be avoided under a Rule 403 analysis. In addition or as an alternative to applying Rule 403 when outlying scientists' research has been developed for litigation and has been neither published in independent scientific journals nor peer reviewed, judges may apply Rule 702 as demonstrated by Judge Kozinski in *Daubert* on remand.[141] But when alternative models are recognized by scientific consensus, the misled fact-finder would be best served by hearing a neutral expert's report on the state of scientific opinion, contextualizing the outlying views so that they do not appear to be equal in weight to the scientific consensus.

V. CULTURAL BOUNDARY-CROSSING: FROM SCIENCE TO TRANS-SCIENCE

As science enters the courtroom, it crosses epistemic, discursive, and cultural boundaries. Significant cross-cultural concerns[142] attend the situation of a scientist who would speak science to law. It has long been lamented that scientists who become expert witnesses risk losing their respectability as scientists,[143] and feared that some who do become expert witnesses "will literally offer themselves for hire, selling their opinions and their credentials to anyone who meets their price."[144]

Lawyers' awareness of and respect for cross-cultural interests would do much to facilitate their work with expert witnesses, and to mitigate the risk of reputational harm to the scientists with whom they work. A legal fact-finding focus on procedure implies that lawyers and judges need not themselves become

140. Naomi Oreskes, *The Scientific Consensus on Climate Change*, 306 SCIENCE 1686 (2004).

141. Daubert v. Merrell Dow Pharms., 43 F.3d 1311 (9th Cir. 1995).

142. John Barkai, *Cultural Dimension Interests, the Dance of Negotiation, and Weather Forecasting: A Perspective on Cross-Cultural Negotiation and Dispute Resolution*, 8 PEPP. DISP. RESOL. L.J. 403, 404 (2008) ("Cross-cultural differences create such a high degrees of friction and frustration that they put business deals in jeopardy, make disputes more difficult to resolve, and create international incidents." (footnote omitted)).

143. Mnookin, *supra* note 124, at 1010–11.

144. *Id*. at 1011. *See also* THE FEDERAL JUDICIAL CENTER, *supra* note 138, at 14 (reporting a judge's description of a case in which "Outstanding experts in the field on both sides . . . had become advocates.").

scientists to perform their professional functions. Their task need not entail mastering the details of substantive fields of science. Instead, the judge must develop a basic familiarity with the substance of pertinent science—along with an understanding of what science is, how it is produced, and what scientists mean when they speak professionally. The necessary understanding of science is a form of cross-cultural understanding that is accessible to judges and lawyers.[145]

Cross-cultural communication entails a need for translation: not only of scientific language, but of the characteristics of scientific research that flow from scientific procedural norms and professional commitments with respect to the epistemological quality of their work. These characteristics subtend the strength of scientific objectivity-claims—the authority of science that lawyers seek. Lawyers need to recognize their own professional commitment to preserve the epistemological character of the science that they use to support their arguments. Without acting to preserve this character in interdisciplinary translation, their arguments rest on distorted material that weakens the argument and misleads the fact-finder.

For example, lawyers can learn to recognize and work with scientists to mitigate the cross-cultural difficulties with testifying in a form that changes the grey areas of scientific discourse into the black-or-white of the courtroom. A scientist who is called to testify as an expert witness finds herself interpellated by both scientific and legal norms when she tries to answer: she is in court because she is a scientist, but she must testify in a form appropriate not to a scientist, but to a participant in the litigation process. Her testimony will be the speech act of Schrödinger's expert: her scientific opinion is framed in terms of probabilities, but when she opens her mouth to answer "yes" or "no," she will be converting her opinion from probability to certainty in the fact-finder's ears.

Testimony is a speech act[146]: it does not simply convey information as would any speech, but also confers authority on the speech's content and enters that content into the evidentiary record of the trial. The need for translation from scientific opinion to the testimony of a witness in litigation can be overlooked—particularly when the witness is unaware that she is caught in a normative crisis when she is called to perform as a scientist on the stage of the law.

Even when the witness can identify this problem, this translation is difficult for one who is not an expert in both science and law. Like the scientist-turned-policy advisor, the expert witness may feel it improper to answer with a number that

145. For example, the movement in legal education towards creative problem-solving could prepare lawyers to work effectively across disciplines. *See* Janet Weinstein, *Coming of Age: Recognizing the Importance of Interdisciplinary Education in Law Practice*, 74 WASH. L. REV. 319 (1999).

146. Speech act theory points out that an utterance can have effects beyond simply conveying the information represented in its words. J.L. Austin, *Performative Utterances*, *in* THE PHILOSOPHY OF LANGUAGE 136 (A.P. Martinich, ed., 5th ed. 2008); John Searle, *Speech Acts*, *in* THE PHILOSOPHY OF LANGUAGE 146 (A.P. Martinich, ed., 5th ed. 2008).

represents safe levels of a toxin in the environment, but the expert witness will have less room to reframe or to evade the question than would a scientific committee consulted in the legislative process. The lawyer can help the scientist understand the need for translation, and develop a translation that signals the discursive shift from science to law, preserving the character of science by explaining her professional assessment of research results while also explaining her personal opinion of their implications.[147] This translation would accomplish the best that Weinberg explains science can offer to litigation: drawing the boundary between science and trans-science.

Lawyers can also learn to help scientists to make an appropriate translation when an expert witness has a scientifically sound opinion that clearly weighs in favor of one of the litigants' arguments. Scientists whose testimony clearly favors one side may experience a kind of awkwardness, feeling the normative pressure of science to present their opinions in impartial, neutral ways. While the lawyer is committed to supporting one side when he builds his arguments, a scientist would be committing malpractice if she were to commit to an outcome and then perform only experiments the results of which would support that outcome. However, once a scientist has properly and independently completed a research project, it is not only acceptable but desirable for her to teach the public what her results mean—even if they clearly favor one side *ex post*. Lawyers can help expert witnesses to articulate the differences between conducting research to obtain the "right" answers that have been determined *ex ante*, and conducting research responsibly to find out and explain which answers to the research question are best supported *ex post*.

Lawyers can also help scientists to realize that their cultural convention of acknowledging and identifying uncertainty can be exploited, even when there is widespread agreement as to the validity of research results within the scientific community.[148] Therefore, while in some ways the effects of science on our society, economy, and culture are obviously profound, the authority of science can be overwhelmed relatively easily in the courtroom.

For example, science alone cannot solve even environmental problems that are understood largely through scientific study, but have multiple trans-scientific dimensions. Lawyers must work with scientists to identify and articulate the science that will inform our resolution of the trans-scientific aspects of environmental disputes. The court regards a scientific expert witness as an authority

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147. For example, atmospheric scientists Stephen Schneider and Richard Moss developed accessible ways for scientists to express their confidence in various outcomes for use in advising policymakers on climate change. *See* Jim Giles, *Scientific uncertainty: When doubt is a sure thing*, 418 NATURE 476 (2002).

148. Newman, *supra* note 1, at 424–25 ("[W]hen a scientist's progress is scrutinized in court, the strengths of a tolerant and exuberant method that fosters creativity become fodder for aggressive cross-examination. The strengths of scientific endeavor—its uncertainty, evolution, questioning and open-endedness—are weaknesses on the witness stand.").

because of her specialized knowledge. The role of the scientific expert in litigation is to educate the legal fact-finder, so that the fact-finder will be able to understand scientific evidence. Lawyers must assist this fact-finder in recognizing whether the evidence has been presented in a scientifically appropriate manner. Because legal authority subsumes scientific authority in informing itself, to maintain its integrity, the legal institution must at a minimum ensure that the scientific building blocks are not misshapen when it incorporates them into its own building that establishes, maintains, and houses the social order.

A. HOMONYMS: WATCH OUT FOR UNMARKED DISCURSIVE INTERSECTIONS

> *A curious state of affairs: the two cultures, their paths crossing in the corridors of justice, using in their ordinary language opposite definitions of the simple word "fact," and not knowing they are doing so.*[149]

To work effectively with science, lawyers must develop a critical awareness of how epistemological language works in each discipline. Key terms that are superficially identical in the languages of science and law are actually terms of art with distinctive meanings in each. Fundamental misunderstandings ensue when a lawyer is unaware that crucial terms relating to truth and professional judgment in law and science, such as "fact," "uncertainty," and "proof," are superficially identical but actually homonymous. Not only are the denotations of these terms distinct, but their significance differs with cultural and institutional differences between the discourses in which they are embedded, and their homonymy (e.g., "fact" in law, "fact" in science) affects the clarity of interdisciplinary interaction.[150] Educating lawyers about these terms and their implications enables them to translate between the disciplines more effectively, assisting the public in using the best science to inform legal decisionmaking.

Outside the boundaries of its discursive realm, the term "scientific fact" may sound as though it points to a conclusively determined bit of reality, when instead it may refer to a data-point out of context, or to a scientific map that is reliable

149. *Id.* at 423.

150. Elizabeth Mertz, *Translating Science into Family Law: An Overview*, 56 DEPAUL L. REV. 799, 800 (2007) (footnote omitted):

> There is often an assumption of transparency, as if science and law spoke the same language. In this view, all lawyers have to do is take the results that emerge from scientific studies and apply them to legal problems. . . . . But it may be that science begins with different ideas about how to define the problems themselves, or with a different conception of the goals of obtaining knowledge in the first place. When this is the case, law may be absconding with "answers" that only remotely resemble the scientific findings from which they supposedly derive. An assumption of transparency may give lawyers a false sense of certainty[.]

even though (and because) it is subject to revision to increase the strength of its claim to objectivity. The finding of a "scientific fact" in litigation is misleading without translation. Referring to an account that is embedded in a scientific discourse as a "fact" when speaking in a legal context removes that scientific map-feature from the processes that give it meaning, and pulls it into a discursive realm in which a "fact" is, by construction, a more definite and persistent object. This move has epistemological consequences, freezing a dynamic object and assigning it an absolute truth-value. Such an unmarked redefinition can be profoundly misleading as a very context-sensitive scientific account is silently rendered into a fixed basis for legal judgment.

Even though the primary goals of litigation may be resolution of an instant dispute and the establishment of broader social order, the justice of the resulting decision and order depends on the accuracy (and reliability) of the bases for its reasoning. The more accurate the facts are, the more firmly grounded the judgment can be. Where truth cannot be found, it is declared[151]—yet the epistemic gaps between the declared fact, science's best account at the moment, and the bit of reality for which the declared fact passes all matter to the quality and sustainability of the judgment.

The Federal Rules of Civil Procedure, the Federal Rules of Evidence, and the Model Rules of Professional Conduct all reflect legal professional duties to avoid misrepresentation and fraud before the court. A lawyer who draws from the realm of science without building a translational bridge over the law-science epistemic gap risks misrepresenting facts and uncertainties before the court; a lawyer who intentionally exploits the play between legal and scientific uncertainty commits a fraud upon the court, a sleight-of-hand behind the unmarked redefinition of a homonymic term. A judgment that relies on the unlabeled goods can only be sound by accident.

Lawyers have a duty to translate facts and uncertainties from science to law: to create a legal account of them that preserves their significance, so that the court may be well advised to rely on them. Translating scientific objects into legal objects entails preserving their character—preserving their integrity, and so their authority. Not only is such translation dutiful practice for the lawyer, but pragmatically it strengthens the arguments that he hopes to support with scientific authority. If the lawyer reaches beyond his discipline for persuasive support, and the science that is supposed to be supportive is distorted in the process, then:

151. *Id.* at 800–01:

> What counts as a legal fact can bear little relationship to the kinds of facts with which scientists deal. Legal facts emerge from the application of legal procedures and rules, which produce legal certainty (i.e., the issue was properly before the court, the rules of evidence were followed). The jury may make a mistake, but unless what it decided was clearly erroneous, its decision will stand as a legal fact. This would make little sense under the rules of scientific proof[.]

(1) his argument may appear weaker because he made such a reach to support it; (2) the support is damaged, having lost its original force through distortion; and (3) the legal argument that rests on the far-fetched, damaged support is itself undermined. Ethically and pragmatically, a lawyer does well to be aware that translation is required and to effect it.

It may seem a heavy burden for the lawyer who wants to bring science into law to have to account for it, but professionalism in both disciplines entails representational accountability. Scientists are ethically bound to make their utmost, good-faith efforts to avoid distortion in their accounts of nature. Scientists are feeling further responsible for providing accounts of their work to the public in a form useful for legal decisionmaking, and are deeply concerned about how to accomplish that translation without decreasing the accuracy and reliability of their research.[152] Lawyers who make their best, good-faith efforts to represent science properly will be able to establish strong, clear connections across the interdisciplinary gap. Basing legal decisions in our best knowledge does much to protect the legal process from arbitrariness, and thus promotes the rule of law.

B. LEGAL NEUTRALS SHOULD BE ASSISTED BY SCIENTIFIC NEUTRALS

Judges can help to resolve some of the procedural and epistemic tensions affecting the scientific expert witness by respecting her professional need to be recognized as neutral. As discussed *supra* Part IV.B.2, courts and the public may benefit from the assistance of scientific neutrals who are called not by either side, but by the court to assess relevant science for the fact-finder. Too often, one side's experts will report the consensus of a large international group of scientists that has crystallized over decades, while the other side's experts will have been hired to emphasize the uncertainty that is inherent in all science and bias their report to emphasize data that has not persuaded the majority of scientists, but is favorable to their interests. Scientists who are not involved in advocacy for any party, but who serve only the court, could be appointed under Rule 706.

When a scientific consensus is clear, a single expert witness could inform the court without misleading framing: the neutral scientific fact-finder's voice enters the courtroom through the neutral legal fact-finder. When scientific opinion is diverse, a diverse panel of scientists could inform the court from a neutral position, accurately representing the diversity of scientific opinion rather than framing scientific opinion as if it evenly reflected the opposed views in litigation to which it may not correspond at all. Independent and credible scientific organizations can recommend scientists who represent current scientific opinion. Further, if scientists report a unified, consensus view to the court, the court may

152. Gary K. Meffe, *Conservation Scientists and the Policy Process*, 12 CONSERVATION BIOL. 741 (1998).

consider applying Rule 403 to ensure that presentations that appear to bear the imprimatur of science, but are offered merely to oppose accurately represented scientific opinion, are not offered if their probative value is substantially outweighed by their risk of confusing or misleading the fact-finder. Alternatively, the court may instruct the jury that these views are presented as non-consensus views, and their presentation should not give the appearance of evenly divided scientific opinion.

C. TO PROMOTE SETTLEMENT, HAVE ONE SIDE'S SCIENTISTS TALK TO THE OTHER SIDE'S SCIENTISTS

The ability of scientists to form consensus around scientific issues may invite people who are dealing with related legal issues to form their own consensus, and may assist them in doing so.[153] For example, supranational communities, called "epistemic communities," are commonly formed by scientists in a given field, across numerous steep cultural, political, economic, and linguistic barriers.[154] Scientific experts might be useful in negotiating settlements of particular classes of cases, such as patent infringement suits. Scientific expert witnesses are not in court to advocate zealously for the side that hired them; they are present only to educate the legal fact-finder.[155] This function could be used in negotiation to help the parties to develop a clearer understanding of the scientific merit of their claims.

D. THE LAWYER MUST EDUCATE THE LEGAL FACT-FINDER ABOUT SCIENTIFIC FACT-FINDING

Though science began as a liberalizing, democratizing enterprise that shifted social power from a religious class to the laity, some critics have pointed out that a scientific class has formed: especially with the development of expensive, cumbersome experimental technology that is neither accessible to all nor straightforward in its use, only experts have become truly empowered to perform and speak in the name of science.[156] In the spirit of their Enlightenment heritage, scientists should work to make science accessible to the general public, particularly when it critically informs legal decisionmaking. Science experts should educate the legal fact-finder about the provisionality of science and its specialized usage of the term "uncertainty." Although the U.S. Supreme Court has expressed its awareness of the provisionality of science and its ever-present

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153. Freeland, *Maieusis Through a Gated Membrane*, *supra* note 3, at 451–65.
154. Peter Haas, *Introduction: Epistemic Communities and International Policy*, 46 INT'L ORG. 1 (1992).
155. *See, e.g.*, Daubert v. Merrell Dow Pharms., Inc., 509 U.S. 579, 592 (1993).
156. *See, e.g.*, STANLEY ARONOWITZ, SCIENCE AS POWER (1988).

acknowledgment of uncertainty,[157] awareness of these qualities often eludes the legal fact-finder. Scientists need to make clear that qualifying statements very carefully is a conventional practice within scientific culture, and that such terminology reflects more the skepticism of the responsible scientist than the utility or empirical reliability of the idea. It must not be assumed that the legal fact-finder understands this. To fail to alert the fact-finder to the significance of scientific acknowledgement of uncertainty is to fail in one's social responsibility as a scientist. In parallel, better public education in science could make a tremendous contribution to the appropriate use of scientific research results in legal processes. If the relative rigor of the scientific findings presented in the courtroom were plain to all, those who would equate scientific uncertainty with ignorance would have a harder time making an appearance of legitimacy for their claims.

Scientific expert witnesses also should call attention to distinctions between questions that can be answered using the scientific method (scientific questions) and those that cannot (such as political questions). For example, in environmental law the question of how much pollution, degradation, or environmental stress is too much—the "give me a number" question that the policymaker asks the scientist—is actually a trans-scientific question, not a scientific one. For example, one leader of the international negotiation of the Kyoto Protocol of the United Nations Framework Convention on Climate Change expressed frustration with the scientific experts of the Intergovernmental Panel on Climate Change: when he asked them to give him numbers—levels of air pollutant emissions that were tolerable—so that he could facilitate consensus-formation among various parties to the negotiation, the scientists refused to do so. Their research indicated that *all* air pollutant emissions were harmful. Since we do not have enough earths with which to conduct proper experiments, there was no quantitative scientific answer to how much pollutant emission could be tolerated by whom under which conditions. Even if experiments could have been performed, a "tolerable" level of emissions depends on the levels of adverse health effects that a society considers acceptable. Such trade-offs are political decisions that vary with the subject-positions of those willing and able to make them.

Scientists must make their informed, professional assessments of a situation clear and accessible to non-scientists. They must explain the methods, results and implications of science as clearly, honestly and completely as they can. When asked a question like, "What does this research say about the watershed?" the scientist is holding the ball, and will affect the outcome of litigation. While she must acknowledge her lack of omniscience, she would be irresponsible if she

157. "Of course, it would be unreasonable to conclude that the subject of scientific testimony must be 'known' to a certainty; arguably, there are no certainties in science." *Daubert*, 509 U.S. at 590.

were to say, "I don't know—your guess is as good as mine," when the question is a scientific question and the science suggests an outcome. Being responsible for scientific research means being prepared to articulate an opinion, even if it clearly favors one side.

When scientific research has implications for legal decisionmaking, it also would be irresponsible for a scientist to state her assessment and then withdraw her authority by allowing scientific uncertainty to be mistaken for ignorance. When participating in solving problems in society, in negotiating policy, in legal proceedings, or in making political decisions, scientists participate not only as experts but as citizens, as members of society at large. Being responsible citizens means not abandoning one role in trying to perform the other.[158]

E. PROFESSIONALISM IN LAW AND SCIENCE

Legal realists, like rigorous scientists, retained the skepticism and critical perspective that struggles to prevent complacency from settling into the professional community and misinformation from infiltrating their professional judgment. Skeptical of the objectivity claims of law, legal realists persisted in calling attention to the political interests embodied in the purportedly apolitical lawmaking process. Some who refrained from taking the positivistic leap of faith in the direction of law nonetheless took it in the direction of science, and sought to inform the law with sociological research results, as did Brandeis in arguing *Muller v. Oregon*.[159] Legal realists who refrain from treating science as a pristine (or at least for the pragmatist, adequate) foundation for law share the critical rigor of the most respected scientists. Accordingly, legal historians like Morton Horwitz regard criticism, rather than sociology, as the most valuable legacy left to us by the legal realists.[160] Critical perspectives can improve our legal institutions by informing and adding to the impetus for beneficial changes in our legal system, by better informing its pragmatic compromises, and by helping to ensure that these compromises will serve as stepping-stones to a better, more equitable and inclusive legal system, rather than allowing the system to harden into an ever imperfect, oppressive weight.

Both legal and scientific authority are based on world views that are incomplete in ways that matter, despite their basis in claims to objectivity. Both employ

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158. CSEPP, *supra* note 17, at 20–21:

> If scientists . . . find that their discoveries have implications for . . . public affairs, they have a responsibility to call attention to the public issues involved. They might set up a suitable public forum involving experts with different perspectives on the issue at hand. They could then seek to develop a consensus of informed judgment that can be disseminated to the public.

159. Muller v. Oregon, 208 U.S. 412, 419 (1908) (reporting Brandeis and Goldmark's collected sociological data "to the effect that long hours of labor are dangerous for women, primarily because of their special physical organization."). *See supra* text accompanying note 95.

160. HORWITZ, *supra* note 89, at 193–212.

reductionistic approaches to complex problems, so that those problems can be tractable in some way rather than in none at all. Pragmatism is preferable to helplessness. That we can build law and science so well should inspire our determination to make them even better. Both science and law reflect the teleological aspirations that through rigorous, uniform application of agnostic procedures, we will draw ever nearer to true understanding and a just society.[161] Modes of communication that respect the professionalism of *both* lawyers and scientists will be most effective in speaking science to law.

161. This was recognized by the U.S. Supreme Court in *Daubert v. Merrell Dow Pharms., Inc.*, 509 U.S. 579, 597 (1993) ("In the endless process of testing and retesting, there is a constant rejection of the dross and a constant retention of whatever is pure and sound and fine." (quoting BENJAMIN N. CARDOZO, THE NATURE OF THE JUDICIAL PROCESS 178–79 (1921))).