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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

AUTHOR'S NOTE

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ENDNOTES

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

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

[3] Ibid., 781.

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

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

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

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

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

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

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

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

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

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

[14] Ibid.

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

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

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

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

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

[20] Ibid.

[21] Ibid., 155.

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

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

[24] Ibid.

[25] Ibid., 559 – 560.

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

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

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

[28] Ibid., 317.

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

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

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

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

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

[34] Ibid., 590.

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

[36] Ibid., 360.

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

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

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

[40] Ibid.