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Inquiry and Advocacy, Fallibilism and Finality: Culture and Inference in Science and the Law

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Science is the search for truth—it is not a game in which one tries to beat his opponent . . . [Linus Pauling][1]

If . . . a judge [is] presiding over the hearing of a case, that cause must be decided somehow, no matter how defective the evidence may be . . . But the idea of science is to pile the ground before the foot of the outworks of truth with the carcasses of this generation, and perhaps of others to come after it, until some future generation, by treading on them, can storm the citadel. [C. S. Peirce][2]

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1. The nature of science and the culture of law

Reflecting on the interactions of science and the law—on those constitutional cases over creationism in science classes, for example, or on legal wranglings over whether ancient human remains must be given for burial to the Native American tribes who claim them, or may be investigated by scientists to determine their origin; and, especially, on the difficulties the legal system has encountered in handling scientific testimony—you soon begin to suspect that there are deep and consequential tensions between science and the law. Peter Schuck alludes to these tensions when he describes the interactions of the law with science and with politics as a kind of 'multiculturalism', and Steven Goldberg when he writes of the 'culture clash' of law and science in America.[3]

But the 'two cultures' model is in some respects potentially misleading; 'the nature of science and the culture of law' might be a better way to put it. For, though science surely is, among other things, a social institution, scientific inquiry arises from a desire to understand and to control natural phenomena, and so is responsible to the character of the world it investigates as well as constrained by the cognitive powers and limitations of

[1] Emily Morrison Beck (ed.) *Familiar Quotations*, (Boston, MA: Little, Brown, and Company, 1980); the date given for the quotation from Pauling is 1958.

[2] Charles Sanders Peirce, in Charles Hartshorne *et al.* (eds.) *Collected Papers of C. S. Peirce*, (Cambridge, MA: Harvard University Press, 1931–58); the quotation is from a lecture of 1898.

[3] Peter Schuck, 'Multiculturalism Redux: Science, Law and Politics', 11 *Yale Journal of Law and Public Policy* (1993) 1; Steven Goldberg, *Culture Clash: Law and Science in America* (New York: New York University Press, 1994). See also David Kaye and Sheila Jasanoff, Symposium on the Contrasting Cultures of Law and Science, 32 *Jurimetrics* (1992), 313.

human inquirers. In consequence, while details of its practice and etiquette vary with time and place, science is essentially the same the world over. Legal systems, on the other hand, arise in response to human conflicts, to disputes; and, though no doubt broadly constrained by facts about human nature and society, are much more largely the product of convention, coming into existence only because of human institutional practices. In consequence, legal systems are local, specific to a time and place, in a way that science is not.[4]

When I speak in what follows of 'the culture of the law', I will mean, specifically, the present culture of the US legal system; and I shall be exploring the differences between science and this legal culture signalled by my title and my opening quotations: (1) between the adversarialism of the law, and the investigative procedures of the sciences; and (2) between the concern of the law for prompt and final resolutions, and the open-ended fallibilism of the sciences, the ever-present possibility of revision. Adversarialism and the concern for finality, I shall argue, significantly amplify the inevitable difficulties in handling scientific testimony, which is why those difficulties have prompted some notable compromises of finality and modifications of adversarialism.

2. Inquiry and advocacy, fallibilism and finality

'Science', as I construe it, picks out a loose federation of kinds of inquiry;[5] 'law', on the other hand, *Webster's* dictionary tells us, refers to 'a body of customs, practices, or rules of conduct recognized as binding or enforced by a controlling authority', It is important not to overstate the contrast. A scientific investigation is an attempt to arrive at the truth of some question; but so too, it is often said, is a trial: in a 1966 ruling, for example, the Supreme Court averred that '[t]he basic purpose of a trial is the determination of truth';[6] one of the avowed goals of the Federal Rules of Evidence (1975) is 'that the truth be ascertained'; in her introduction to the 1996 National Institute of Justice Report on DNA evidence then-Attorney General Janet Reno affirmed that '[o]ur system of criminal justice is best described as a search for truth' [7]

But it is no less important not to understate the contrast, to acknowledge, with Justice Blackmun, the 'important differences between the quest for truth in the courtroom and the quest for truth in the laboratory' [8] At a trial a jury is asked to decide whether guilt or liability has been established to the desired degree of proof. This is a very special kind of inquiry into a very special kind of proposition, and is constrained not only by the demands of evidence, but also by considerations of principle and policy: that it is worse to convict the innocent than to free the guilty; that constitutional rights must be observed;[9] that

[4] My thanks to Mark Migotti for very helpful discussion of the issues raised in this paragraph.

[5] No doubt some will disagree with the conception of science I shall offer in what follows; but this is not the place for a detailed engagement with instrumentalist, constructive-empiricist, social-constructivist, etc., philosophies of science, for which the reader is referred to Susan Haack, *Defending Science—Within Reason: Between Scientism and Cynicism* (Buffalo, NY: Prometheus Books, 2003).

[6] *Tehan v United States*, 382 US 406, 416, 86 S. Ct., 459, 465 (1966).

[7] Janet Reno, 'Introduction' to National Institute of Justice, *Convicted by Juries, Exonerated by Science: Case Studies in the Use of DNA Evidence to Establish Innocence After Trial* (1996).

[8] *Daubert v Merrell Dow Pharm. Inc.*, 509 US 596–597, 113 S. Ct., 2786, 2798 (1993).

[9] The ruling in *Tehan* (*supra*, note 6) continues: 'By contrast, the Fifth Amendment's privilege against self-incrimination is not an adjunct to the ascertainment of truth ... [but] stands as a protection of quite different constitutional values ... .'

people should not be discouraged from making repairs which, if made earlier, might have prevented the events for which they are being sued; and so on. Moreover, the procedures of a trial are quite unlike those of ordinary scientific or historical inquiry, or even of investigative journalism or detective-work; as is the very special division of labor inherent in our adversarial system, where competing advocates, held to legally proper conduct by a judge, present the evidence on the basis of which a jury is to arrive at its verdict.

Scientists, like historians, detectives, investigative journalists, legal and literary scholars, etc. are by profession inquirers. Inquiry is an attempt to discover the truth of some question or questions; so the obligation of a scientist, *qua* inquirer, is to seek out all the evidence he can, to assess its worth as impartially as possible, to draw conclusions only if and as the evidence warrants doing so, and when the available evidence is inadequate to justify any answer, to try, acknowledging that at present he simply doesn't know, to get better evidence.[10] Attorneys, by contrast, like lobbyists or clergymen,[11] are by profession not inquirers, but advocates. And advocacy is an attempt to make a case for the truth of some proposition or propositions; so the obligation of an attorney, *qua* advocate, is to seek out evidence favoring the proposition(s) in question, to present it as persuasively as possible, and to play down or explain away unfavorable evidence—or to look for legal grounds for its exclusion.

Once again, it is important neither to overstate nor to understate the contrast. Science is the work of many people, both within and across generations, often in co-operation with each other—but sometimes in competition, with proponents of rival theories or approaches seeking out the flaws and difficulties in a competing theory that its proponents are motivated to play down or ignore. Such competition can be a real spur to intellectual effort, as with James Watson's (probably exaggerated) perception that he and Crick were racing against Pauling and his team to solve the structure of DNA. But what Watson wanted wasn't *simply* to 'win the game'; it was *to discover the truth about DNA* before Pauling did. Scientists' competition for priority is very different from attorneys' competition to win a case. Sometimes a scientist may succumb to the temptation to become an advocate for a favorite theory; he may even indirectly advance the scientific enterprise by doing so, for the fact that scientific inquiry is a community affair can compensate, up to a point, for individuals' failure to live up to their obligations as inquirers. But even when science is at its most competitive, its procedures are very far from the formal adversarialism of a trial, and there is no real analogue of the formalized legal division of labor between attorneys, judge and jury.

As Peirce says, the idea of science is to keep working at a question, sometimes for generation after generation, until the truth is reached. By now, there is a vast body of scientific knowledge, well-warranted by evidence, and unlikely to be overturned. But many, many scientific questions are as yet unanswered (not to mention those as yet unaskable), and not all scientific theories are well-supported by good evidence: most get discarded as the evidence turns out against them; nearly all, at some stage of their careers, are

[10] This is not, of course, to deny that in applied science—in medicine or engineering for example—practical decisions may have to be made in the absence of good evidence.

[11] As Samuel Butler writes: 'We forget that every clergyman with a living or curacy is as much a paid advocate as the barrister who is trying to persuade a jury to acquit a prisoner.' Samuel Butler, *The Way of All Flesh* (1903; New York, NY: The New American Library of World Literature, 1960), 102.

only tenuously supported speculations; and even the best-warranted are potentially subject to revision should new evidence require it. For preparedness to revise even the most entrenched claim in the face of unfavorable evidence is essential to the scientific enterprise; as is agnosticism: a willingness, that is, to admit that you just don't know. In the law, however, a judgment must be reached—a 'quick, final and binding' judgment, in Justice Blackmun's words[12]—however weak or defective the available evidence may be. Peirce suggests that this is why the law needs standards of proof; more clearly, it is why the law needs statutes of limitations, restrictions on the introduction of new evidence, and final courts of appeal.

Justice requires not only just laws, and just administration of those laws, but also factual truth—which, increasingly often, the courts must rely on scientists to supply.[13]. But because of the tension of the law's concern for finality with the fallibilism of the sciences, the legal system sometimes asks more of science than science can give: when it needs an answer to some scientific question (is Bendectin teratogenic? does this minuscule sample of blood come from the victim? do silicone breast implants promote systemic connective-tissue disease?), there may still be legitimate, reasonable disagreement among scientists in the relevant field, or agreement that no warranted answer is yet available; and when a warranted answer *is* available, it may be legally too late—this is new evidence, no longer admissible, the period within which you may prosecute or sue has elapsed, etc.

And because of the tension between adversarialism and inquiry, the legal system often gets less from science than science could give: attorneys are motivated by the demands of their profession to seek out experts willing to shade or select the evidence as their case demands, and may encourage maverick, marginal or less-than-honest scientists into the lucrative business of the professional expert witness—perhaps keeping factual issues in legal dispute long after the scientific community has come to see them as pretty firmly settled.

3. Legal rules of admissibility of scientific testimony

So it is hardly surprising that it has proven difficult to harness science to the culture of the law—in particular, to domesticate scientific evidence by means of legal rules of admissibility.

In early medieval times, English courts sometimes relied on tests by oath and ordeal, which were based on the assumption that God would punish those who swore falsely, would ensure that an innocent man's arm was not scalded if he plunged it into boiling water, and so forth. In 1215, however, the fourth Lateran Council prohibited priests from taking part in such tests. In early jury trials, rather than witnesses being called, jurors could go around and investigate for themselves; and in cases where specialized knowledge was required they might be selected for their expertise—e.g. a jury of hatters when the defendant was accused of selling badly-made caps; or the court itself might call an expert—e.g. a master of grammar to help construe doubtful words in a bond. The custom of calling witnesses gradually grew up, and then the adversary system, with cross-examination and

[12] *Daubert*, 113 S. Ct. at 2798.

[13] According to Howard M. Erichson, one study found expert testimony employed in 86% of civil trials, with an average of 3.3 expert witnesses per trial. See Howard M. Erichson, 'Mass Tort Litigation and Inquisitorial Justice', 87 *Georgetown Law Journal* (1999), 1983, 1986.

formal rules governing the admissibility of evidence, until eventually there were expert witnesses in something like the now-familiar sense: experts proffered by the parties and asked, not to testify to what they saw, but to give their informed opinion.[14]

For a long time it was required only that a scientific witness, like any other expert witness, establish his qualifications as an expert; until 1923, when the *Frye* ruling imposed new restrictions on the proffered testimony itself. In *Frye*, excluding testimony of a then-new blood-pressure deception test, the D.C. court ruled that novel scientific evidence was admissible only if it had gained 'general acceptance in the field to which it belongs' [15] At first cited only rarely, the '*Frye* rule' gradually came to be widely followed in criminal trials, and by 1975 had been adopted in most states. This rule is a better proxy for scientific robustness, obviously, when the field in question is a mature, established scientific specialty than when it is a highly speculative area of research, or, worse, the professional turf of a trade union of mutually supportive charlatans; and it can be made more or less demanding depending on how broadly or how narrowly the relevant field is specified. Nevertheless, the *Frye* rule was commonly criticized as too restrictive.

The Federal Rules of Evidence enacted in 1975 set what was perceived to be a less restrictive standard: the testimony of a qualified expert is admissible provided only that it is relevant, and not excluded under Rule 403 on grounds of unfair prejudice, waste of time, or potential to confuse or mislead the jury. In *Barefoot* (1983) the Supreme Court affirmed that the constitutional rights of a defendant in a Texas capital case were not violated by admitting psychiatric testimony of his future dangerousness—even though an amicus brief from the American Psychiatric Association reported that two out of three predictions of future dangerousness are wrong. Writing for the majority, Justice White observed that state and federal rules of evidence 'anticipate that relevant, unprivileged evidence should be admitted and its weight left to the fact-finder, who would have the benefit of cross-examination and contrary evidence by the opposing party' [16]

But by the late 1980s—as legal scholars debated whether the Federal Rules had or hadn't superseded *Frye*, and whether a more or a less restrictive approach to scientific testimony was preferable—there was rising public concern that the tort system was getting out of hand. In 1991 Peter Huber argued in his influential *Galileo's Revenge* that the crisis was largely due to scandalously weak scientific testimony that would have been excluded under *Frye*, but was being admitted under the FRE. In 1992 proposals to tighten up the FRE were before Congress. In 1993 the Supreme Court issued its landmark ruling in *Daubert*, a Bendectin case—the first case in its 204-year history where the Court ruled on the standard of admissibility of scientific testimony.

The FRE had superseded *Frye*, the Supreme Court ruled; but the Rules themselves require judges to screen proffered expert testimony not only for relevance, but also

[14] According to Learned Hand, the first case of an expert witness as exception to the rule that the conclusions of a witness are inadmissible was in *Alsop v Bowtrell*, Cro. Jac. 541 (1620). Learned Hand, 'Historical and Practical Considerations Regarding Expert Testimony', 15 *Harvard Law Review* (1901), 40, 45. According to Stephan Landsman, one of the earliest cases of expert witnesses called by the parties and subject to cross-examination was *Folkes v Chadd*, 3 Doug. 157 (1782). Stephan Landsman, 'Of Witches, Madmen, and Product Liability: An Historical Survey of the Use of Expert Testimony', 13 *Behavioral Science and Law*, (1995), 131, 141. The revised Federal Rules of Evidence enacted in 2000 now allow limited opinion evidence from lay witnesses.

[15] *Frye v United States*, 54 App. D.C. 46, 293 F.1013 (1923).

[16] *Barefoot v Estelle*, 483 US 880, 898, 103 S. Ct., 3383, 3397 (1983).

for reliability. In doing this courts must look, not to an expert's conclusions, but to his 'methodology', to determine whether proffered testimony is really 'scientific ... knowledge', and hence reliable. Citing law professor Michael Green citing philosopher of science Karl Popper, adding a quotation from Carl Hempel for good measure, the *Daubert* court suggested four factors for assessing reliability: whether the proffered testimony can be or has been tested; the known or potential error rate; peer review and publication; and (in a nod to *Frye*) acceptance in the relevant community. In dissent, however, pointing out that the word 'reliable' nowhere occurs in the text of Rule 702, Justice Rehnquist worried aloud that federal judges were being asked to be amateur scientists; anticipated difficulties over whether and if so how *Daubert* should apply to non-scientific expert testimony; and questioned the wisdom of his colleagues' foray into philosophy of science.

Perhaps the *Daubert* court was drawn into its unfortunate philosophical excursus by that all-too-common honorific use of 'science' and 'scientific' as generic terms of epistemic praise—as, in television advertisements, actors in white coats urge us to get our clothes even cleaner with new, 'scientific' Wizzo. At any rate—quite apart from the confusion of Popper's and Hempel's very different philosophies of science, and quite apart from the inappropriateness of looking to Popper, who insists that scientific claims can never be shown to be true or even probable, and explicitly repudiates any concern with reliability,[17] for an account of what makes evidence reliable—the fundamental problem is that *no* criterion could identify the 'methodology' that discriminates the scientific, and hence reliable, from the unscientific and unreliable.[18] For not all, and not only, scientists are good, reliable inquirers; and there *is no* 'scientific method' in the sense the Court assumed, i.e. no uniquely rational mode of inference or procedure of inquiry used by all scientists and only by scientists. Rather, as Einstein once put it, inquiry in the sciences is 'nothing but a refinement of our everyday thinking',[19] superimposing on the inferences, desiderata, and constraints common to all serious empirical investigation a vast variety of constantly evolving, and often local, 'helps': instruments of observation, special mathematical or statistical techniques of reasoning, and so forth.

So it should come as no surprise that, only four years after *Daubert*, the Supreme Court's philosophical chickens came home to roost in *Joiner*, a toxic tort case involving PCB exposure.[20] Now, quietly backing away from its reliance on Hopper, Pempel, falsifiability, etc., the Supreme Court denied the legitimacy of the distinction between methodology and conclusions on which it had insisted in *Daubert*. And only two years after that—trying to sort out the problems with non-scientific experts which, as Justice Rehnquist had anticipated, soon arose in the wake of *Daubert*—in *Kumho*, a product-

[17] The degree of corroboration of a theory, Popper writes, is a matter of its past performance only, and '*says nothing whatever about future performance, or about the 'reliability' of a theory.*' Karl R. Popper, *Objective Knowledge: An Evolutionary Approach* (Oxford: Clarendon Press, 1982), 18.

[18] For detailed development of this argument, see Susan Haack, 'Trial and Error: The Supreme Court's Philosophy of Science', presented at the Coronado Conference on Scientific Evidence and Public Policy organized by the Tellus Institute, in March 2003; forthcoming in *American Journal of Public Health* and, abridged, under the title 'Disentangling *Daubert*', in the American Philosophical Association *Newsletter on Philosophy and Law* (fall 2003).

[19] Albert Einstein, 'Physics and Reality', (1936), in *Ideas and Opinions of Albert Einstein*, trans. Sonja Bargmann (New York: Crown Publishers, 1954), 290.

[20] *General Electric Co. v Joiner*, 522 US 136, 118 S. Ct., 512 (1997).

liability case involving a tire blowout,[21] the Court ruled that the key word in Rule 702 is 'knowledge', not 'scientific'; what matters is whether proffered expert testimony is reliable, *not* whether it is science. Indeed.

However, far from backing away from *Daubert*'s commitment to judges' gatekeeping responsibilities, the *Joiner* court affirmed that a judge's decision to allow or exclude scientific testimony, even though it may be outcome-determinative, is subject only to review for abuse of discretion, not to any more stringent standard; and the *Kumho* court, stressing that the *Daubert* factors are 'flexible', ruled that a judge may use any, all, or none of them. A year after *Kumho*, revised Federal Rules made explicit what according to *Daubert* had been implicit in Rule 702 all along: admissible expert testimony must be based on 'sufficient' data, the product of 'reliable' principles 'reliably' applied to the facts of the case.

Despite the *Daubert* court's observations about the Federal Rules' 'liberal thrust', *Daubert* and its progeny are in some ways significantly *more* restrictive than *Frye*. In practice, it seems, since *Daubert* courts have been tougher than before on expert testimony proffered by plaintiffs (though apparently less so on expert testimony proffered by prosecutors in criminal cases). In any event, as a result of *Daubert*, *Joiner* and *Kumho*, federal judges now have substantial responsibility and broad discretion in screening expert testimony, but very little guidance about how to do this.

4. Adaptations of adversarialism

Perhaps needless to say—but perhaps not—sometimes it can be really *hard* to tell whether proffered expert testimony is relevant and reliable; for doing so will sometimes require substantive knowledge in the area of expertise in question. No wonder, then, that besides efforts to domesticate scientific evidence by means of legal rules, there have also been some notable adaptations both of adversarialism and of the concern for finality, accommodating the legal culture to scientific testimony.

Since 1975, under FRE 706 and many state equivalents, a court has had the power to 'appoint witnesses of its own selection' The provision has not been used on a regular basis,[22] but as judges' gatekeeping responsibilities have grown, some have been willing to call directly on the scientific community for help. Used in a number of asbestos cases between 1987 and 1990, the practice was adopted in the late 1990s in response to a wave of lawsuits against the manufacturers of silicone breast-implants, most notably by Judge Samuel Pointer, to whom several thousand such federal cases had been consolidated. In 1998, Judge Pointer's four-member National Science Panel reported that the evidence did not warrant claims that the implants caused the systemic connective-tissue diseases attributed to them; six months later, a 13-member committee of the Institute of Medicine reached the same conclusion. Before the panel members' testimony had been transcribed, the cases were settled. In other cases, court-appointed experts have advised judges on the

[21] *Kumho Tire Co. v Carmichael*, 526 US 137, 119 S. Ct., 1167 (1999).

[22] In a 1988 survey, Joe Cecil and Thomas Willging of the Federal Judicial Center found that 20% of judges had appointed an expert, most of them just once.

potential dangers of seat-belt buckles, the diet drug fen-phen, and the anti-lactation drug Parlodel; and in the Court of Appeals in Michigan, on Bendectin.[23]

Reading the plaintiffs' attorneys' depositions of the members of the Pointer panel, you may smile wryly at the mutual incomprehension revealed, for example, when a scientist is asked to produce her time-sheets; or wince uncomfortably at the revelation that, while serving on the panel, Dr Peter Tugwell signed a letter asking for financial support for another project from one of the defendant companies. And you might reasonably worry about just four scientists' being, in effect, responsible for the disposition of thousands of cases, or wonder what will happen if court-appointed scientists disagree. Still, the conclusion the panel reached was almost certainly correct, and the upshot preferable in many ways to the familiar, drawn-out legal lottery in which the same scientific issues are litigated over and over, with some plaintiffs winning huge awards and others nothing; and, though there are both legal and practical difficulties with the use of court-appointed experts, judges could learn a lot from Judge Pointer's experience about the pitfalls of choosing scientists to advise them, instructing those scientists on record-keeping and conflict of interest, and so on. There is no denying, however, that—more radically than *Frye*'s oblique deference to the relevant scientific community, more radically even than *Daubert*'s (and *Joiner*'s and *Kumho*'s) extension of judges' gatekeeping powers—reliance on court-appointed experts represents a departure from the traditional adversarial culture. Proponents have recognized this from the beginning; and so do contemporary critics of the practice, who complain that it is a move in the direction of an 'inquisitorial' system, 'elitist' and 'undemocratic', even 'totalitarian'. I grant, of course, that trial by jury is a much better way of getting at the truth than trial by oath or ordeal, and citizens' service on juries a desirable expression of the democratic ethos.[24] Even if space permitted, however, I would not be in a position to undertake a comprehensive comparison of the merits of adversarial and inquisitorial legal systems (or perhaps 'more and less adversarial legal systems' would be a more accurate phrase).[25] But I will venture to say that I don't believe civics education for jurors could justify avoidable, consequential factual errors; and that a willingness to adapt the adversarial culture a little doesn't seem unreasonable if it would better serve the fundamental purpose of protecting citizens from arbitrary and irrational determinations of fact.

5. Compromises of finality

It is, indeed, precisely unwillingness to tolerate the consequential factual errors revealed by newly available scientific techniques that has led to the other cultural adaptation mentioned earlier, the compromises of finality. In the late 1980s, testimony of the results of then-

[23] *DePyper* et al. *v Paul V. Navarro*, No. 191949, 1998 WL 1988927 (Mich. App. Nov. 6, 1998); 'Denial of Expert Witness Testimony Violates *Daubert*, Appeal States', *DES Litig. Rep.* (December 1998).

[24] It is worth noting, however, that the proportion of cases decided by juries is now quite tiny. According to William Glaberson, only 4.3% of federal criminal charges end in a jury verdict, and only 1.4% of federal civil cases are resolved by juries. William Glaberson, 'Juries, Their Power Under Seige, Find Their Role is Being Eroded', *New York Times* (March 2nd, 2001).

[25] But see e.g., Herbert Liebesny, *Foreign Legal Systems: A Comparative Analysis* (1981), 327–45; John Langbein, 'The German Advantage in Civil Procedure', 52 *University of Chicago Law Review* (1985), 823; Petra Van Kampen, *Expert Evidence Compared: Rules and Practices in the Dutch and American Criminal Justice System* (1998).

new techniques of DNA 'fingerprinting' was strenuously contested in the courts; but as the solidity of DNA evidence, and its power to enable justice, became unmistakable, the 'DNA Wars' gradually died down. By now, DNA testing has not only helped convict numerous rapists and murderers, but also exonerated many convicted prisoners, including a significant number on death row.[26] The ripple effects have been noteworthy. Doubts about the death penalty have been reinforced—indeed, in 2002 a U S District Court judge in New York ruled that the likelihood of the government's executing innocent people was now known to be so high as to render the death penalty unconstitutional.[27] The realization that many other innocent people have probably been convicted on the same kinds of flawed evidence as those who have been exonerated by DNA has prompted renewed scrutiny of eye-witness testimony, of confessions, and of such other forensic evidence as hair analysis, fingerprints, etc. (scrutiny enabled in small part by the fact that, unlike *Frye*, *Daubert* is not restricted to 'novel' scientific testimony). And, most to the present purpose, some of the legal restrictions on new evidence, statutes of limitations, and so on, have gradually been modified.

Many jurisdictions, for example, have enacted statutes allowing convicted prisoners access to DNA testing.[28] Some states have increased the statute of limitations on crimes for which DNA evidence may be available; and some prosecutors have begun to issue 'John Doe' warrants, identifying suspects only by their DNA, on the eve of the expiration of the statute of limitations, effectively tolling the statute should the suspect's DNA turn up in one of the data-banks.[29] It is salutary to remember that the brouhaha over 'recovered memories' also prompted some modifications of statutes of limitations, to enable prosecution of (supposed) long-ago crimes. Still, when as with DNA identifications new scientific work makes it possible to establish that an innocent person has been convicted, it is surely reasonable to be willing to consider compromising finality in the service of truth.

6. 'Culture and inference' in science and the law

I chose my subtitle, ' "Culture and inference" in science and the law', for its resonance with the reference in the title of this conference to 'Inference, Culture and Ordinary Thinking' in dispute resolution; but as the work proceeded I found the 'culture' part coming to predominate over the 'inference' part. This is probably because I am less than optimistic about the prospects for formal-logical or mathematical models of the quality of evidence, whether in legal contexts or anywhere else. As I have argued elsewhere, the determinants of evidential quality, though objective, are not formal: there is no mode of inference used by all and only scientists; there is no syntactically characterizable inductive logic; and, since neither a proposition nor its negation may be warranted to any degree, degrees of warrant don't satisfy the axioms of the calculus of probabilities.[30] Hence my focus on the

[26] For a list, see http://www.innocenceproject.org.

[27] Jess Bravin, 'Death Penalty is Struck Down by District Court Judge: Appeal is Likely', *Wall Street Jounnal* (July 2, 2002), D5 (referring to *United States v Quinones*, 2002 WL 1415648 (S.D.N.Y., 2002)).

[28] See Kathy Swedlow, 'Don't Believe Everything You Hear: A Review of Modern 'Post-Conviction' DNA Testing Statutes', 38 *California Western Law Review* (2002), 355 n.2, for a list and some restrictions.

[29] See Mark Hansen, 'The Great Detective', 87 *American Bar Association Journal* (2001), 37.

[30] See Susan Haack, 'Puzzling Out Science', *Academic Questions* (1995) 25, reprinted in Haack, *Manifesto of a Passionate Moderate: Unfashionable Essays* (Chicago, IL: University of Chicago Press, 1998); 'Clues to the

epistemologico-cultural questions I have tackled here: How does the adversarialism of the legal culture, and its concern for finality, contribute to its difficulties in handling scientific testimony? and, What modifications of that culture might prove adaptive, improving factual accuracy without needless sacrifice of other values?

Puzzle of Scientific Evidence', 5 *Principia* (2001), 253; and *Defending Science—Within Reason* (*supra*, note 5). That degrees of warrant are not identifiable with mathematical probabilities casts no doubt on the correctness of the probability calculus as such; but it does suggest that its usefulness in epistemology is likely to be limited at best.