Fighting Legal Innumeracy

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An old joke quips that lawyers go to law school precisely because they never liked math or were never good at math – and that therefore medical school (or these days, Wall Street) was not an option. While this tired joke may have a kernel of truth, I want to suggest that we should be very wary of internalizing it. Numeracy is a fundamental skill for any intelligent, engaged participant in society, and we lawyers ignore it at our peril.

I. Numeracy and Innumeracy

The term "innumeracy" was coined by Douglas Hofstadter in a 1982 article in *Scientific American* and perhaps made famous by John Allen Paulos.[1] In his book, Paulos observes that while readers frequently condemn grammatical errors, wild mathematical ones often pass undetected.[2] If this observation is true for anybody, it is

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[1] John Allen Paulos, Innumeracy: Mathematical Illiteracy and Its Consequences (2001); Douglas R. Hofstadter, *Metamagical Themas: Number Numbness, or Why Innumeracy May Be Just as Dangerous as Illiteracy*, Scientific American, at 20 (May 1982).

[2] Paulos, *supra* note 1, at 3-4.

definitely true for lawyers. Playing gotcha with typos is practically the official sport of the bench and bar.[3] Yet, lawyers and courts notoriously make incorrect numerical calculations – sometimes caught, sometimes not – but generally without the same snarky rebukes.[4]

The primary focus of Hoftstadter and Paulos, however, is on the inability of the public to grapple with *numbers*. Accordingly, they stress the importance of estimation and orders of magnitude. For example, just how big is a billion dollars, or a trillion dollars? Or more trivially – though not so for aspiring management consultants – how many ping-pong balls will fit into a backyard swimming pool?

I want to recast the numeracy problem to be a bit more law-centric. For lawyers, numeracy should be less about numbers per se and more about statistical inference or how to interpret and understand scientific or social scientific studies. The last few decades have seen a tremendous increase in the number of legal areas reliant on such methods: Disparate impact employment discrimination litigation depends on statistics, as does proof of causation in toxic torts. Proper valuations of damages or corporate assets require quantitative models, and perhaps most famously, DNA evidence in criminal cases involves vanishingly small random match probabilities such as 1 in 4 trillion.

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[3] *E.g.*, United States v. Devine, 787 F.2d 1086, 1089 (7th Cir. 1986) ("The brief was desultory in nature; in general a poorly written product with numerous typographical errors. It was obviously never edited by a caring professional. As a panel of judges already overburdened with cases and paper, we find it insulting to have to dutifully comb through a brief which even its author found little reason to give such attention. We condemn this type of shoddy professionalism."); *see also* Mary Whisner, *When Judges Scold Lawyers*, 96 LAW LIBRARY J. 557 (2004).

[4] *See* Brown v. Farwell, 525 F.3d 787 (9th Cir. 2008) (affirming grant of habeas in case in which prosecution's DNA expert committed transposition fallacy); Lisa Milot, *Illuminating Innumeracy*, 63 CASE W. RES. L. REV. 769 (2013); *see also* David H. Kaye, *The Transposition Fallacy in Brown v. Farwell*, at lawprofessors.typepad.com/science_law/2008/05/the-transpositi.html. Indeed, in *United States Department of Commerce v. Montana*, 503 U.S. 442 (1992), a voting apportionment case, the Supreme Court too made a rather significant mathematical error. Paul H. Edelman, *Getting the Math Right: Why California Has Too Many Seats in the House of Representatives*, 59 VAND. L. REV. 297 (2006).

Even outside the courtroom, legal academics have seen statistics become a mainstay of empirical legal studies. So not only are statistical studies important to proving facts at trial, but they are also important for understanding how our legal system works.

The ability to comprehend, critically assess, and explain these kinds of studies constitutes "legal numeracy." To be clear, legal numeracy does not mean the ability to conduct the studies themselves. It does not entail collecting data, constructing models, and programming computers to fit the models. The goal of legal numeracy is not to turn lawyers into amateur statisticians. Rather, legal numeracy involves the ability to be an educated consumer, to critique and think intelligently about what statistical studies mean, and then perhaps most importantly, to explain the relevant ideas to factfinders.

II. The Perils of Legal Innumeracy

Given this definition for legal numeracy, what are the dangers of *in*numeracy? When faced with statistical information, the innumerate exhibit two extremes in behavior. Either they defer, or they ignore – something that sociologist Joel Best has labeled the "Naïve" and "Cynical" models of handling statistics.[5]

In the deference story, lawyers internalize the "lawyers aren't good at math or statistics" story, and end up relying entirely on experts and being at their mercy. Experts take the stand, give their qualifications, and then the legal system receives the expert's knowledge without much criticality.[6] The innumerate assess a statistical study based on journal reputation only or whether an expert is likable and credible. If these factors are satisfactory, the innumerate will then simply defer to the conclusions. This strategy has obvious risks.

The flip side of the deference story is neglect. Here, the innumerate conclude that statistics are basically infinitely manipulable lies (in the spirit of Mark Twain's "lies, damned lies, and statistics"), or a mountain of incomprehensible gibberish not worth taking time

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[5] Joel Best, Damned Lies and Statistics 160-71 (rev. ed. 2012).

[6] *See generally* Ronald J. Allen & Joseph S. Miller, *The Common Law Theory of Experts: Deference or Education?*, 87 Nw. U. L. Rev. 1131 (1993).

to understand. In either case, the statistical studies are ignored entirely. This strategy too has significant costs. Statistical studies are of course information, and to ignore them is to lose valuable evidence.

This dichotomy – between deference and neglect – is not new. In perhaps the most celebrated case involving law and probability, *People v. Collins*,[7] the dichotomy took center stage. In *Collins*, a 1968 case before the California Supreme Court, the prosecution introduced a probability professor from a local community college who testified about the "product rule," the basic rule that allows one to multiply the probabilities of two independent events, like coin flips. The probability of two heads is a half times a half, which is a quarter. The problem is that when the events are not independent, multiplying things only leads to foolishness. The probability of a red card in a deck of cards is a half, whereas the probability of a heart is a quarter. But because all hearts are red, the probability of a red heart is still a quarter, not the eighth that one gets by multiplying.

The prosecution, however, proceeded on this primrose path, assigning probabilities to various defendant attributes – moustache, beard, yellow car, an interracial girlfriend. It then multiplied them together to arrive at a chance of innocence of 1 in 12 million, mangling the laws of probability along the way.[8]

The California Supreme Court reversed in part because of these technical problems, but more importantly for numeracy purposes, it also reversed in part because of concerns that mathematics acted as a "veritable sorcerer" – casting a spell over the jury in its search for truth.[9] But notably, while the court's concern was deference, the truth was more about neglect. Interviews with jurors after trial generated this quote: "I don't remember our discussing the professor much when we deliberated. Maybe we were overwhelmed by the numbers."[10]

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[7] 68 Cal. 2d 319 (1968).

[8] *See id.* at 325-26 & n.10.

[9] *Id.* at 320.

[10] George Fisher, *Green Felt Jungle: The Story of* People v. Collins, in EVIDENCE STORIES 16 (Richard Lempert ed., 2006).

Incidentally, within all this talk of deference and neglect, how did the California Supreme Court actually discover the horrendous mistakes? Who was the numerate lawyer who saved the day? Well, in a twist of fate, one of the law clerks that term was a young Laurence Tribe. Tribe had been a math major.[11]

Lawyers need to treat studies with neither deference nor neglect. Statistical studies are neither magic nor snake oil, and the experts neither sorcerers nor (generally speaking) charlatans. Rather, what legal actors need to do is treat statistical studies *critically*. As the statistician George Box once warned, "[r]emember that all models are wrong; the practical question is how wrong do they have to be to not be useful."[12]

This critical perspective on statistical studies, which I have now labeled as "legal numeracy," is in many ways the vision that the Supreme Court laid out in its now-famous 1993 *Daubert* case.[13] *Daubert* nominally rewrote the *federal* rule governing scientific evidence, but in reality touched off a revolution in scientific evidence nationwide, if not worldwide. Prior to *Daubert*, the dominant doctrine for assessing scientific evidence was the *Frye* standard.[14] *Frye* allowed experts to testify if their methods were generally accepted in the relevant scientific community. This *Frye* model, you will undoubtedly note, was one based on deference.

Daubert changed all that. Conventionally, *Daubert* is thought of as a watershed case that eliminated junk science and charlatans from the courtroom. That "achievement," though, is controversial, because what is junk to the defense is gold to the plaintiffs and vice versa. What is often missed about *Daubert*, however, is how it changed the nature of debate over scientific expertise in courts. Gone are the days of deference in which credentialing and the *ipse dixit* of the ex-

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[11] *Id.*

[12] GEORGE E.P. BOX & NORMAN R. DRAPER, EMPIRICAL MODEL BUILDING AND RESPONSE SURFACES 74 (1987); BEST, *supra* note 5, at 17 (". . . [E]very statistic has flaws. The issue is whether a particular statistic's flaws are severe enough to damage its usefulness.").

[13] Daubert v. Merrell Dow Pharmaceuticals, 503 U.S. 579 (1993).

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

pert were sufficient. In its place, Justice Blackmun tasked judges as gatekeepers – a new role in which judges must understand, grapple with, and assess expertise critically. And with the judge's newfound responsibility comes the attorney's responsibility to understand and shepherd this information – often statistical information.

The job of assessing statistical studies is not easy, and some trial judges have predictably attempted to punt. In 2005, one district court admitted expert testimony while raising a white flag:[15] the court conceded that it could not "fully and fairly appreciate and evaluate the methodology employed by either of [the expert] witnesses as they reached the conclusions that they reached,"[16] and thus punted the assessment of the scientific evidence to the jury. The Eleventh Circuit could scarcely contain its contempt. It reversed, finding the court's disavowal "of its ability to handle *Daubert* issues [to be] an abuse of discretion."[17]

So in many ways, *Daubert* tasks all lawyers with the goal of numeracy and the critical handling of statistical studies. We thus have the responsibility of acquiring and helping others acquire this skill set.

III. The Way Forward

So how do we meet *Daubert*'s challenge? How can we promote greater numeracy within the legal profession?

The first thing is that legal actors – be they judges, attorneys, academics, or students – need to gain confidence. We need to demand, without embarrassment, that quantitative researchers not only explain the conclusions of their studies, but also how and why the methods work and the limitations. It is simply not sufficient for an expert to ask for and receive our trust. And it is certainly inadequate for experts to dismiss questions from lawyers with responses like "That's how it's always done."

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[15] McClain v. Metabolife, 401 F.3d 1233 (11th Cir. 2005).

[16] *Id.* at 1238 & n.3 (quoting trial court opinion).

[17] *Id.* at 1238. These attempted abdications may be more common than one might suspect. *See, e.g.*, Barabin v. AstenJohnson, Inc., 740 F.3d 457 (9th Cir. 2014).

All of us, regardless of background, are capable of understanding at a conceptual level how various statistical techniques work and why the resulting inferences are valid. If an expert refuses to explain things to us at this level, then we should question the expert's facility with the methods and ask whether we should give the expert's conclusions any weight at all.

Some of us undoubtedly have memories of speakers who didactically asserted that their preferred method was *the* correct method with little explication as to why, not so subtly implying that those who disagreed or inquired further were clearly fools. These scare tactics are exactly that – attempts at intimidating audience members into acceptance. If the expert cannot explain things to your satisfaction, then the problem is not you, it is the expert.

Second, beyond confidence, lawyers need to become more numerate. Here, however, my proposal is emphatically not that regression should replace torts in the first-year curriculum or that CLE should require empirical methods. Rather, I want to challenge all of us – but particularly those of us in educator roles – to treat numeracy just like any other legal skill.

In reflecting on the numeracy problem, it has occurred to me that there are many opportunities to teach numeracy skills in my classes, yet I have historically never done so. Statistical studies frequently appear in cases or inform case outcomes, yet I have typically presented the conclusions at face value, rather than engaged in a critical discussion. Sometimes I felt like it would take too much time, sometimes I thought it would be unwelcome or boring to students, and still other times, I thought that grappling with statistical studies was not part of the project of teaching law. In retrospect, this seems to be the wrong approach.

One basic example from my evidence class: Federal Rule of Evidence 803(4) establishes an exception to the hearsay rule for statements made for purposes of medical diagnosis. The rationale is that people tend not to lie to doctors because it is critical to proper treatment, and thus such statements are more reliable.

The Eighth Circuit has held that the rule, however, does not apply to a three-year-old, essentially because three-year-olds do not

understand the need to be truthful to doctors.[18] The casebook I use[19] contains a research article, prompted by the Eighth Circuit case, suggesting that five- and six-year-olds have a much better understanding of the importance of truth-telling to physicians than three- and four-year-olds.[20] In class, I've always simply deferred to the conclusion, suggesting perhaps that the line should be set at age five.

What I could do instead of deferring, however, is take a few minutes to force the students to be critical: Was the sample size of forty children sufficient? Was the sample representative, or did it skew toward especially articulate children? (After all, only certain parents of certain children will take them to be interviewed.) Were the observed differences sufficiently large to reach a definitive conclusion? And finally, if we think the answer to any of these questions is no, what are the implications for courts the next time they hear such cases?

Just as instructors should and do take minutes out of a class or presentation to point out an interesting lawyering tactic, a statutory interpretation issue, or a theoretical link, so too should we occasionally take opportunities to show others how to be legally numerate. Numeracy is as much a legal skill as the more traditional ones.

We can all do better at developing these abilities and sharing them with each other, just as we would our critiques of a court's legal analysis or observations about litigation strategy. And through this subtle shift, almost by osmosis, we will become more confident and more numerate consumers of statistical information.

[18] GEORGE FISHER, EVIDENCE 539 n.* (2013); *see also* Ring v. Erickson, 968 F.2d 760 (8th Cir. 1992).

[19] FISHER, *supra* note 18.

[20] Melody R. Herbst, et al., *Young Children's Understanding of the Physician's Role and the Medical Hearsay Exception*, in CHILDREN'S UNDERSTANDING OF BIOLOGY AND HEALTH 235 (Michael Siegal & Candida C. Peterson eds., 1999).