

LAW AND CONTEMPORARY PROBLEMS

Volume 64

Autumn 2001

Number 4

FOREWORD

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The idea for this issue of *Law and Contemporary Problems* and the conference that preceded it arose from my work in judicial education over the last dozen years. Over that period, Duke Law School's Private Adjudication Center has sponsored an annual program called "Judging Science," a week-long, intensive seminar in the scientific method and its various applications for trial and appellate judges from around the country. The program was conceived by Paul Carrington of Duke Law School and the late Maurice Rosenberg of Columbia. I participated as a statistics instructor in the early years and over the last several years have been the program's director.

Over those dozen years, the single issue that has vexed the participating judges more than any other is the relationship between causation in law and causation in science. Their vexation has been exacerbated, of course, by the legal burdens imposed on them by the *Daubert* cases.¹ Over and over again, judges have expressed frustration with what they perceive to be science's equivocal, almost backhanded approach to causation: deciding whether A caused B not by direct proof, but by excluding all other plausible hypotheses. At the same time, they have ardently sought after ways to translate scientific proof of causation into the law's language of "more likely than not" and "beyond a reasonable doubt." They have rarely been pleased when my faculty colleagues and I have tried to explain why a direct translation is simply not possible. On more than one occasion, we have been accused, with considerable warmth, of academic evasiveness.

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1. See *Daubert v. Merrell Dow Pharms., Inc.*, 509 U.S. 579 (1993); *General Electric Co. v. Joiner*, 522 U.S. 136 (1997); *Kumho Tire Co. v. Carmichael*, 526 U.S. 137 (1999).

I finally concluded that the charge, while fundamentally unfair, did have an element of truth. Perhaps both science and the law needed to confront directly each other's understanding of causation, to assess carefully and comprehensively the similarities and differences between the two, and to survey promising sites for building bridges. My approach to this quandary was to triangulate: to assemble a group of scientists, lawyers, and philosophers of diverse intellectual experience to think about the problem from their own perspectives. The whole, I hoped, would be greater than the sum of the parts. I believe that the effort has paid off.

A collection such as this does not yield a single answer to the question of "What is causation?"—and appropriately so, for there is no such answer. It does, however, illustrate vividly the multiplicity of ways in which people who make and interpret the law, who think about its nature, and who create the scientific evidence that the law consumes conceive of the answer. By thus illuminating the connections and disjunctions among these various perspectives, this collection will, I hope, enhance the process of communication and understanding between the law and the sciences.

The creation of this volume began in November 2000, with an editorial conference at Duke Law School that was sponsored by the Private Adjudication Center ("PAC"). Prior to the conference, all of the authors posted preliminary drafts on PAC's website. Then, over the course of two days, each paper was presented formally, with extended opportunities for comment and discussion. The finished products that appear in this volume embody each author's reflection on that process.

Several of the papers take as their starting point the kinds of evidence that scientists rely on to prove causation, and then raise questions about the law's reception of that evidence. Carl F. Cranor, a philosopher, and environmental toxicologist David A. Eastmond analyze the patterns of scientific evidence in toxic tort cases and ask whether the law makes appropriate use of this evidence in making its own judgments about causation. They conclude that judicial ignorance of scientific causation, working in concert with the current rules for the admissibility of scientific evidence and the traditional burdens of proof, can cause courts to dismiss toxic exposure problems that scientists view as quite real. Statisticians David A. Freedman and Philip B. Stark consider the specific example of the alleged relationship between swine flu vaccine and Guillain-Barré Syndrome, with particular attention to the epidemiological concept of relative risk. Their subtle but persuasive critique and reanalysis of the underlying scientific data provide a strong reminder of how just how difficult (and perilous) it can be for the law to translate scientific ideas of causation into its own terms. Douglas Crawford-Brown, a physicist who studies environmental issues, assesses the use of scientific models of human health risk analysis in framing legal policy. He identifies two attributes of science that pose particular problems for legal and political decisionmakers: the fact that science is properly practiced by a community, rather than by autonomous and authoritative indi-

viduals; and the related fact that science is a forward-looking, ongoing process without definitive endpoints.

Other papers take the law's perspective as their starting point. Legal philosophers Richard Fumerton and Ken Kress wrestle with a problem that has vexed their discipline: whether it is possible to separate normative from non-normative causal factors. They examine recent efforts to go beyond the law's traditional reliance on "but for" causation by defining a category of "necessary elements of a set of sufficient conditions" ("NESS"). They find the NESS concept promising but ultimately inadequate. Joseph Sanders, a law professor and scientific evidence scholar, and lawyer Julie Machal-Fulks address the question of the admissibility of qualitative differential diagnosis testimony to prove specific legal causation in toxic tort cases. Surveying an extensive body of case law, they find that apparently inconsistent results can often be explained on the basis of the courts' willingness to factor their general evaluations of the strength of the underlying science into their judgments on the admissibility of individual expert opinions. Laural L. Hooper, Joe S. Cecil, and Thomas E. Willging of the Federal Judicial Center (the research arm of the federal courts) report on two major practical efforts to assist courts in dealing with complex scientific evidence. They describe and evaluate the work of two court-appointed expert panels charged with assessing whether breast implants cause systemic connective tissue disease.

Two other papers deal with specific communication problems between lawyers and scientists. David W. Barnes, a tort law specialist as well as an economist, discusses the propensity of some judges to try to mesh scientific calculations of statistical significance (which often produce numbers that look like error rates of less than five percent) with the rough-and-ready fifty-one percent probability often used to characterize the civil burden of persuasion. Barnes warns strongly against such oversimplification, stressing that legal decision-makers simply cannot avoid understanding and evaluating scientific and statistical methods on their own terms. On a related topic, statistician David W. Peterson and I take up the particular problem of the *p*-value, a statistic that scientists routinely calculate in deciding whether chance is a plausible explanation for their observations. We identify a number of situations in which courts can be misled by the misuse of *p*-values, and argue for a change in the rules of discovery to control such abuses.

Two pairs of authors report on their empirical studies of how the process of causal reasoning actually works. Social psychologists Barbara A. Spellman and Alexandra Kincannon have conducted a series of experiments designed to assess how lay people deal with difficult causal problems of the sort that often come up in the law—for example, events with multiple sufficient causes. They find that in a variety of such situations, lay people not only sort out complex causal conundrums in rational ways, they also arrive at legally correct judgments without the "benefit" of legal instructions. Lawrence M. Solan, a law professor and linguist, and social psychologist John M. Darley have done an ex-

perimental study of how people reason about “enabling torts” (cases in which, for example, the defendant has left the keys in the ignition and someone steals the car and gets into an accident, or has allowed a social guest to drink too much and the guest causes injury while driving home). Their results show that people are inconsistent in their judgments about liability in such cases, often merging the logically separable categories of enablement and causation into a more general category of contribution. Solan and Darley suggest that their respondents’ judgments can help to explain a parallel confusion between enablement and causation that permeates the tort case law.

Finally, two papers attempt to put the question of causation into far more expansive contexts. Physician and medical historian Warren Newton looks at the issue across time, reviewing centuries of tension between rationalism and empiricism in the evolution of the modern practice of medical diagnosis. His paper strikingly illustrates the divisions within the scientific world that the law too often idealizes as monolithic. Anthropologist William M. O’Barr’s perspective is cross-cultural. He reminds us that Western notions of causation, whether legal or scientific, are culturally-derived folk categories rather than absolute truths, making his point with reference to a series of famous ethnographic cases.

Readers should not expect to come away from this collection with a transcendent definition of causation that will satisfy both scientists and lawyers. What should emerge, however, is a refined sense of the dimensions of the problem. My hope is that these papers will materially improve the understanding of each side’s point of view, and thereby promote the communication between law and science that is at present so awkward. More specifically, I hope that the judges whose queries stimulated this project will better appreciate why scientists cannot speak about causation as lawyers do. At the same time, I hope that those scientists will see that there are reasons other than obtuseness for the law’s frequent misunderstanding and occasional misuse of their findings.