

Evidence in Context

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Evidence and Epidemiological Trials

A Science or Story of the Individual: N of 1 Trials or Randomized Controlled Anecdotes

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Anecdotes, informal stories, once were the primary medium for transmission of medical knowledge. Analyses of individual persons or events have also been common in psychology, anthropology, law, public policy, accident investigation and many other inquiries. But in medicine, "anecdotal evidence" has become an insult. To say, "that's just anecdotal" means, "you don't know" or "that's not true." Just because a treatment appeared to work once upon a time does not show that it will work generally, or that it ever did work. Anecdotes, indeed any unsystematic accounts, are said to be unscientific and untrustworthy; controlled experiments generate knowledge while anecdotes do not. According to the tenets of evidence based medicine, statistics not individuals, numbers not narrative, experiments not stories show what really works. But there is a hybrid of anecdote and experiment that turns this view on its head: the N of 1 trial, in which the subject is one person. Viewed as science not story, the single person experiment has been deemed to be the highest form of medical evidence. But how does an experiment on one person, whether randomized, controlled, shaken or stirred, differ from an anecdote? Where anecdote and experiment meet, the boundary between story and science blurs. That is, if there is such a boundary at all: the implications of the randomized controlled anecdote extend beyond this special case to all views that purport to distinguish medical knowledge from plausible story.

Epidemiologic Evidence and Interim Analysis in Sequential Trials

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Evidence is a controversial notion in epidemiology. Clinical researchers—much like philosophers and statisticians—disagree about the inferential methods that should be used in establishing evidential relations. Much of statistical methodology used in epidemiology has its origins in principles developed in agricultural studies during the 1920's. But one important difference between R.A. Fisher's early trials and today's clinical trials is the fact that data are accumulated gradually and examined periodically over a period that can extend to multiple years, rendering the original paradigm unsuitable for meeting today's demand of large-multi-center trials.

Happily, statistical methodology has evolved since Fisher. Today, there is an array of statistical approaches that may be used to assess the evidence provided by interim data analyses. While according to several epidemiologists no single approach addresses all possible issues that researchers may face, these methods do provide a useful set of tools to assist them in deliberating about possible emerging trends in the data.

In my talk, I examine different—at times conflicting—methods for assessing evidence via interim data analysis. For instance, group sequential procedures—while embodying a hybrid notion of evidence—assess evidence in terms of the past performance of the data. This is contrasted with modern stochastic techniques where the evidential assessment is about possible future data paths. My analysis will lead us to question the idea of a single principle of evidence in clinical trials, and to suspect that for epidemiologists, evidential notions may be revised in response to new problems and new techniques.

Epidemiological Standards of Evidence as a Strategy of Resistance to the Knowledge Economy

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Epidemiological standards of evidence have often been described and promoted as instruments for achieving efficiency and effectiveness in healthcare as part of Canada's healthcare cost-cutting agenda. Efficient and effective cost-saving solutions are presumed to emerge from the highest quality health research, as determined by following rigorous and objective research methods. In this paper, I would like to explore a different perspective and consider epidemiological standards of evidence as a strategy of resistance to the government agenda to promote economic competitiveness in the global knowledge economy. Science policy and funding programs have increasingly required health researchers to legitimize their research in terms of social and economic utility. It is no longer sufficient to produce knowledge that is rigorous and objective, but it must serve social, political and economic ends. As qualitative researchers and other health researchers using non-traditional research methods have long argued, it is possible to produce useful health research from a multitude of methods and perspectives, even if these fail to be recognized as having any scientific validity according to the epidemiological hierarchy of evidence. The mobilization of clinical and epidemiological researchers to strengthen and defend the 'gold standard' of evidence based on methodological criteria can be understood, in this context, as a strategy to conserve a position of dominance within the health research community, and to resist government imposition of a new definition of high quality health research that may (unintentionally) favour other members of the health research community.

The Epistemology of Evidence

What Kind of Evidence Do We Have For Realism about Astronomical Entities?

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In (1983), Ian Hacking put forward a position known as “entity-realism.” This is a version of scientific realism which recommends a realist attitude only towards certain sorts of entities – namely, those we can demonstrably and regularly manipulate into preferred states. In (1989) he demonstrated some anti-realist consequences of this position. According to entity-realism, one should permanently take an anti-realist attitude towards the entities postulated by the astronomical sciences. This is because human beings will never be able to manipulate astronomical entities in a way that would, for the entity-realist, legitimate a realist attitude towards.

I argue that Hacking has not in fact developed an epistemologically well-motivated position, even in (1983), and that his (1989) prescriptions for anti-realism about astronomical entities and realism about experimental entities are at odds with one another. I illustrate the internal tension in his position in terms of a dilemma for Hacking. On any plausible answer to this dilemma, I argue, Hacking will lose significant ground to anti-realism. This is because his (1983) and his (1989) both fail to show that our evidence for realism about astronomical entities is any different in kind from our evidence for realism about experimental entities.

Amalgamation Functions for Multimodal Evidence

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Sunshine today, I reckon, given the blue sky above, the rising barometer, and after all, it is spring in California. My conjecture is supported with multimodal evidence: the sky, the barometer, the season. A “mode” is a particular way of finding out about the world; a two-way avenue between our world and our beliefs; a technique or study design; an evidential machine. The total set of evidence that is relevant to a hypothesis of interest and that is generated by multiple modes is *multimodal evidence*. Two typical responses to multimodal evidence – that concordant multimodal evidence is conducive to certainty, and that discordant multimodal evidence is conducive to uncertainty – are unsatisfactory.

We should be able to do better: we need principled amalgamation functions for multimodal evidence: to know the impact of multimodal evidence on the confirmation or disconfirmation of a hypothesis, all relevant modes of evidence must be assessed and amalgamated. Most sciences currently have crude amalgamation functions for multimodal evidence, but since multimodal evidence is so poorly understood, we have no way to systematically compare or assess the various multimodal evidence amalgamation functions currently in use. In this paper I briefly sketch the contours of what such a function might look like. Modes of evidence should be assessed on several desiderata, including quality, relevance, salience, and concordance. The ultimate goal is that principled amalgamation functions could help situations of scientific controversy, by serving to constrain disputants' beliefs when confronted with discordant multimodal evidence.

Inconsistency, Compatibility, and Error: Another Look at Reduction

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How scientists can legitimately claim that one theory has been reduced to another has long been an issue for philosophers of science. Characterizations initially sought to describe how a deductive reduction obtained (Nagel 1961); however, these views had difficulty accommodating inconsistencies. In this paper we offer a model of reduction that emphasizes the crucial and often-overlooked role that margins of error play in justifying claims of reduction. In doing so we feel that we are able to reconcile reductions of inconsistent theories by focusing on regions where, under a given margin of error, they are compatible. Furthermore, attention to margins of error allows us better to explain the rationale of scientists that employ limiting processes in reductions (Glymour 1970, Batterman 2002). An additional strength of our account is that it describes contemporary approximation techniques in a more robust fashion than standard accounts (we examine an example from reductive quantum chemistry). Finally, we argue that reductions derive their legitimacy directly from considerations of the margin of error; we claim that a margin of error is deemed appropriate to a specific scientific community at a specific time for myriad pragmatic reasons. We conclude by highlighting the important role that experimental capabilities and results play in deciding the acceptability of an error bound, that is, the very role that ultimately results in a decision as to whether one theory should be claimed to be reduced to another. In this way, we demonstrate that experimental practice is a necessary component of the standards of evidence involved in syntactic theory reduction.

Evidence in Policy

Experts and Explosions: The Canadian Nuclear Debate

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On the occasion of his untimely death in 1967, Robert Sutherland was described by the Ottawa Citizen as "Canada's one man equivalent to the RAND Corporation." Sutherland was trained as an economist and actuary at the University of Toronto where he briefly taught applied statistics. In 1951 he joined the Defence Research Board as an operational researcher. By the time the nuclear debate began in Canada in 1957, Sutherland was the most respected voice within the civil service on Canada's strategic situation and the options open to Canada.

Sutherland's memoranda throughout the nuclear debate were widely circulated within the government. In 1962 he went public with a reasoned article that advocated a pro-nuclear role for Canada. This article first appeared in the International Journal, but it was serialized by the Globe and Mail in October which gave it a national audience. However, the Canadian government ignored the advice of its expert and opted for a non-nuclear role.

By exploring this episode I will discuss the events that created the nuclear debate and the reasons why Sutherland's expert opinion was not heeded. The episode demonstrates that traditional Canadian political concerns like party rivalries, the budget, and election results are far more important than expert opinion in the creation of defence and defence science policies.

Evidence in Economic Engineering: The Case of the FCC Ascending Auctions

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The lack of directly relevant evidence is a particularly important and pressing problem when policies require new institutions, new market mechanisms or when new socioeconomic orders are implemented.

Typical methods in economics like econometric methods or model building provide poor evidence for these policies since statistical or theoretical inference leads the evidence production process by relying on factual information, or on somehow confirmed general principles.

The case of the ascending auctions developed in the 1980s on behalf of the US Federal Communications Commission shows how the evidence production process crucially relies on phenomena-eliciting practices rather than on inference.

Despite being hailed as a major achievement of game theory and experimental economics, the work done by experimental economics designing and implementing ascending auctions is, I suggest, a major and seminal achievement of engineering economics. The methods used show how essential phenomena-eliciting and market-mechanism construction practices are in policy making and policy implementation.

In this paper I suggest a new methodological analysis suggesting that the design and implementation of the FCC ascending auction can be better understood as an example of 'Experimental Parameter Variation', an engineering method based on experimental practices and aimed at finding optimal performances. By doing this, I present some initial ideas on an epistemology of practices and on a metaphysics of capacities implicit in this and other engineering methods and that lie, I argue, at the foundations of the general practice of evidence-based policy making whether directed in the socioeconomic sphere to small local changes or to large scale ones.

Evidence in Historical Context

Bede on Evidence: Exploring the Use of Observation in the Work of the Venerable Bede

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It is a common assumption that the Middle Ages represents a period dominated by reliance on Ancient and religious authority, particularly in its natural philosophy. Although this idea is a significant aspect of the 'medieval mentality' that remains influential in modern scholarship, a careful look at the way medieval scholars used evidence in exploring the natural world suggests that this reading may not be entirely accurate.

The Venerable Bede approaches the natural world as a book that can be interpreted through four modes of theological interpretation. He does not interpret all phenomena equally however, but applies different modes depending on the relation of the phenomena to the direct action of God. In this presentation I intend to explore Bede's use of evidence and how it relates to this program of interpretation.

Bede makes use of observation and observable examples both to convince his reader and also to correct or refute certain arguments made by Ancient authorities. Drawing particularly from Bede's work *De Temporibus Ratione*, I shall suggest that just as Bede's use of interpretation is selective, so is his use of authority. Observation is considered appropriate to support an argument that relates to natural phenomena not closely linked to direct divine action. Authority, and specifically Christian religious authority, becomes important when the phenomena are closely linked to the divine ordering of nature and thus takes on greater theological importance. Bede's use of evidence is highly dependant on context and suggests that he, at least, was not dominated by Ancient authority.

The Edinburgh Medical Essays and Observations: Evidence of Enlightenment?

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The establishment of the medical school at Edinburgh in 1727 has often been described as an important step in laying the intellectual foundation for the Scottish Enlightenment. Various explanations have been advanced for this link between medicine and enlightenment. This presentation will discuss a series of documents that may provide clues to this relationship.

The *Medical Essays and Observations, Revised and Published by a Society in Edinburgh* appeared in five volumes between 1733 and 1744. Consisting primarily of papers submitted by medical practitioners from across Scotland and Britain, it was self-consciously modelled on the *Philosophical Transactions* of the Royal Society. The criteria for the submission of several different kinds of contributions were carefully defined. A close study of these contributors (probably best described as "medical men" i.e. physicians, surgeons, and surgeon-apothecaries) provides a way to map the influence of Edinburgh medicine in the first half of the eighteenth century.

There are a number of ways in which the *Medical Essays* might be interpreted as a fundamentally Enlightenment project. The devotion to Baconian observation is quite clear. The engagement with the periphery in gathering medically useful information reflects the values of British public science. Finally, the "Meteorological Register", a daily record of meteorological instrument readings, provides a particularly convincing illustration of the perceived importance of natural knowledge in improving the foundations of medicine.

The Role of Facts in Francis Bacon's *Novum Organum*

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Lorraine Daston argues that the idea of a "fact" emerged relatively recently, namely in 17th century Europe, with the rejection of Aristotelian science. According to Daston, Francis Bacon aimed to create a new basis for natural philosophy that could be agreed upon by everyone, which led him to endorse theory-free facts. Bacon inverted the importance of theory and fact, elevating facts to the status of the fundamental building block from which to build theories, instead of the other way around as it had been under Aristotle. For Bacon, facts could now serve as evidence for a theory.

In this paper I expand on Daston's account by exploring the details of Bacon's new method. Daston directs us to view Francis Bacon's science as drastically different from the Aristotelian science. However, the differences are more subtle than Daston initially suggests. In particular, Daston overemphasizes to role of anomalies for Bacon, suggesting that Bacon focuses on unusual or rare events to eliminate bias. However, Bacon did not focus on anomalies; they were just one of many kinds of events that Bacon used as evidence from which to derive axioms. Daston also underplays the importance of theory for Bacon. In the end, Daston leaves one with the impression that Bacon believed in theory-free facts, something that N.R. Hanson has encouraged philosophers of science to reject. However, although Bacon introduced thinking about facts as main sources of evidence, it is not clear that Bacon himself believed facts to be theory-free.