

ESSAY REVIEWS

The History of Emergences

*By Lorraine Daston**

Ian Hacking. *The Emergence of Probability: A Philosophical Study of Early Ideas about Probability, Induction, and Statistical Inference.* 2nd edition. 209 pp. + unpaginated introduction, bibl., index. New York: Cambridge University Press, 2006. \$24.99 (paper).

Caveat lector. There are books that can change your life, and this is one of them. Sometime in the spring of 1975, during my first year of graduate school, I came across the first edition of Ian Hacking's *The Emergence of Probability* on the new books table at the library. It had an intriguing title (not "revolution," all the vogue in the mid-1970s, but "emergence"), a still more intriguing subtitle (a "philosophical study" but about "early ideas" rather than *dernier cri* problems in induction and inference such as Nelson Goodman's "grue," the hot topic in my philosophy of science seminar), and it was short, a slim 185 pages of text. I had never managed to read Descartes's *Meditations* in a single sitting, as recommended by the author and my philosophy teachers, but I did devour *Emergence* in one long evening. By the time I had finished, I knew I would be writing my dissertation on the history of probability and statistics. It has taken me much longer, some decades, to digest what kind of history was being pursued under the quiet, precise declaration in the subtitle.

I relate this story about the impact of Hacking's book on myself only because I suspect my name is legion. Certainly the now flourishing studies of the history of probability and statistics and their ramifying applications owed their emergence largely to *Emergence*. Even the work of those historians who had preceded him in the field—such as O. B. Sheynin, Ivo Schneider, and L. E. Maistrov—won a larger audience thanks to the impetus Hacking gave to this previously tiny subspecialty of the history of mathematics. It is most unlikely that the international group of scholars, including Hacking himself, who in 1982–1983 convened at the Zentrum für Interdisziplinäre Forschung in Bielefeld, Germany, under the remarkable leadership of Lorenz Krüger in order to investigate "The Probabilistic Revolution" could have been assembled before the publication of *Emergence*.¹ The most sincere compliment to Hacking's deep and enduring influence on the field is that even his detractors have continued to pose the same question he did, although they take exception to his answers. The circumstances Hacking took to have triggered the emergence of prob-

* Max Planck Institute for the History of Science, Wilhelmstrasse 44, D-10117 Berlin, Germany.

¹ The Bielefeld group produced three collective publications: *The Probabilistic Revolution*, Vol. 1: *Ideas in History*, ed. Lorenz Krüger, Lorraine Daston, and Michael Heidelberger, Vol. 2: *Ideas in the Sciences*, ed. Krüger, Gerd Gigerenzer, and Mary Morgan (Cambridge, Mass.: MIT Press, 1987); and Gigerenzer, Zeno Swijtink, Theodore Porter, Daston, John Beatty, and Krüger, *The Empire of Chance: How Probability Changed Science and Everyday Life* (Cambridge: Cambridge Univ. Press, 1989).

ability are asserted to have happened sooner or elsewhere or in different combinations—but the puzzle to be solved remains one of circumstances and emergence. Hacking created a new area of inquiry by asking a new question, or, better, a new *kind* of question: What are the conceptual preconditions for the emergence of a concept so apparently simple, so useful, indeed indispensable—yet so strangely absent before circa 1650—as the modern notion of probability?

What kind of history is needed to address this kind of question? In the new introduction to this 2006 (and otherwise unchanged) edition, Hacking gestures toward two historiographical models: Michel Foucault's project for an archaeology of knowledge, most memorably set forth in *Les mots et les choses* (1966), and Alistair Crombie's "styles of scientific reasoning," described most compendiously in his *Styles of Scientific Thinking in the European Tradition* (1994). Although it is not difficult to discern affinities to both models, neither does full justice to the startling novelty of Hacking's brand of philosophical history. Foucault may be more dramatic and Crombie more erudite, but Hacking is a brilliant analyst, as clear and sharp-angled as a glass prism splitting white light into spectral colors, producing the same effect of agreeable astonishment. In the 2006 introduction Hacking wryly reports that one perspicacious French reader of *Emergence* described it as a work "in the style of Michel Foucault, though a great deal more clear."² This is so understated as to be seriously misleading. Hacking's clarity is not merely expository (although his style is indeed limpid); it is the bones and sinews of his way of doing history. Without Hacking's extraordinary ability to X-ray arguments and ideas into their essential parts, to articulate minute but telling differences, and, above all, to follow the resulting conceptual *bizarrierie* wherever it might lead, *Emergence* would have been just one of the thousands of historical studies "in the style of Michel Foucault" published since 1966.

Hacking's distinctive approach to history is that of an analytical philosopher who also subscribes to the radical empiricist's creed that there are more things in heaven and earth (and history) than have been heard of in our philosophy. He started with a puzzle made familiar to analytical philosophers by, among others, Rudolph Carnap. The single term "probability" harbors two distinct meanings: it can refer either to a degree of belief or certainty ("epistemic" or "subjective" probability) or to statistical frequencies ("aleatory" or "objective" probability). Each meaning has its characteristic domain of applications and doughty champions; the mathematical theory of probability as axiomatized by A. N. Kolmogorov in 1933³ is consistent with either interpretation. There would be nothing to raise philosophical hackles here if the two concepts of probability could be kept cleanly apart from one another, so that we would know exactly what we were talking about in any given case. Carnap suggested labeling them probability₁ and probability₂, which was about as successful as attempts to distinguish between Dr. Seuss's Thing One and Thing Two. We—philosophers, mathematicians, scientists, *hoi polloi*—incurably conflate the two kinds of probability, and not only when speaking unguardedly. Meteorologists, for example, regularly make predictions like "there is a 70 percent chance of rain tomorrow." Does this

² Ian Hacking, "Introduction 2006: The Archaeology of Probable Reasoning," in *The Emergence of Probability*, n.p. For inscrutable reasons, Cambridge University Press has not seen fit to paginate the new introduction, not even with Roman numerals (so as not to alter the original pagination). All page references in the text are to this edition.

³ A. N. Kolmogorov, "Grundbegriffe der Wahrscheinlichkeitsrechnung," *Ergebnisse der Mathematik*, 1933, 2: 196–262.

mean that (a) on the basis of the available evidence concerning fronts, wind speeds, cloud formations, and the like, the meteorologists are 70 percent certain that it will rain tomorrow, (b) on 70 percent of past days similar to the one in question it has in fact rained, (c) it will rain 70 percent of the time covered by the prediction, or (d) 70 percent of well-informed meteorologists believe it will rain? Option (b) comes closest to the official interpretation, but each (or several simultaneously) of the other options also has had its advocates among meteorologists as well as laypeople.

Where other philosophers saw a conceptual mess that needed to be tidied up, Hacking saw a genuine puzzle, as knotty in its way as that other celebrated seventeenth-century dualism, mind versus matter: Why should there be two kinds of stuff in the world? Why should probability be Janus-faced? Instead of attempting (yet again) to enforce the distinction between the two meanings of probability, Hacking focused on why they are so irresistibly blurred. The very obstinacy of the confusion struck Hacking as less of a nuisance to be lamented than a mystery to be investigated. Why can't we rid ourselves of this conceptual neurosis, which so stubbornly resists the assaults of reason? The Freudian analogy is Hacking's own, characteristically paired with an unexpected bedfellow: "The picture is, formally, the same as the one used by the psychoanalysts and by the English philosophers of language" (p. 16).

Hacking did hold out the hope that perhaps historical analysis might perform the same cure as psychoanalysis: by dredging up the past circumstances that first imprinted probability with its bifurcated birthmark, perhaps the historian could at last dissolve the neurosis. But Hacking expressed this hope tentatively, and it seems to me inconsistent with his central suppositions—namely, that "there is a space of possible theories about probability that has been rather constant from 1660 to the present" and that this space resulted from a "mutation" in earlier conceptual structures that nonetheless have shaped how we can think about probability ever since. If this is so, then dragging the buried prehistory of probability into the light of reason will not suffice to free us from the conceptual space erected in the mid-seventeenth century; another mutation, equally momentous, must open up a new space. Analytical history illuminates—brightly, even brilliantly—but by itself it can neither destroy nor create.

Hacking's mixed metaphors—Foucauldian "spaces," Darwinian "mutations," Freudian "liberation," Oxonian "rules of language"—suggest how difficult it was for even so lucid and exact a writer to describe the shape of the kind of history advanced in *Emergence*. It is a history, following Foucault, punctuated by radical breaks that make what was previously barely thinkable commonplace. Not just individual concepts but whole "conceptual structures" abruptly come into being and pass away. And I do mean abruptly: Hacking famously pinned novelties to dates on the calendar, albeit with self-ironic hyperbole.⁴ The point of these deliberate exaggerations was to outline the jagged contours of this kind of history: novelty could erupt unforeseen like a volcano, altering the intellectual landscape almost beyond recognition. But once the lava cooled, to continue the geological metaphor, the new concepts were truly set in stone. This was why origins mattered so much: the historical conditions under which a concept first solidified determined the scope of its use ever after. "If a concept is introduced by some striking mutation, as in the case of probability, there may be some specific preconditions for the event that determine the possible

⁴ Somewhat more cautious formulations usually follow: "The decade around 1660 is the birthtime of probability." Hacking, *Emergence* (cit. n. 2), p. 85. All the chapter epigrams in Ian Hacking, *The Taming of Chance* (Cambridge: Cambridge Univ. Press, 1990), are given precise datelines: "Potsdam, 12 November 1805."

future courses of development for the concept” (p. 15). Prehistory is destiny. The dual meanings of probability now could therefore be read as a clue to the origins of probability way back when, circa 1660.

What happened circa 1660, according to Hacking, was a fusion of an old notion of probability as authoritative opinion (as in the Jesuit moral doctrine of probabilism attacked so vitriolically by Blaise Pascal) with a new notion of signs engraved into things themselves (as in the Renaissance doctrine of signatures expounded by Paracelsus and others) by the divine author of nature. Natural signs thus became a source of probable authority. “Testimony is support by witnesses, and authority is conferred by ancient learning. *People* provide the evidence of testimony and authority. What was lacking, was the evidence provided by *things*” (p. 32). A new way of reading the signs in things emerged in alchemy, medicine, and other “low sciences” that could not aspire to demonstrative certainty and therefore, as judged by scholastic standards, to knowledge: the concept of internal evidence, in which one thing points beyond itself. The word “concept” is important here: Hacking did not deny that people and even animals had been drawing inferences of the “red in the morning, sailors take warning” sort since time immemorial. The practices of internal evidence are ancient. But the concept, Hacking claimed, emerged only in the mid-seventeenth century, when epistemic probability wed aleatory signs of things: “What happened to signs, in becoming evidence, is largely responsible for our concept of probability” (p. 35). The result was a way of knowing by degrees, in which rational assent could be proportioned to evidence (as John Locke put it a few decades later).⁵ A graduated continuum had opened up between the traditional Platonic, immiscible options of knowledge and opinion. The points along that continuum became the new-style probabilities, which, Hacking concluded, to this day bear the telltale traces of their double origins.

For Hacking, as an expert in the philosophy of probability and statistical inference, the denouement of the story was not the calculus of probabilities, as codified by the early eighteenth-century works of Jakob Bernoulli and Abraham De Moivre, but, rather, Hume’s problem of induction. Hacking distinguished Hume’s “sceptical” from the “analytic” problem of induction: the latter refers to how the internal evidence for a hypothesis mounts as the count of confirming instances rises, the problem Bayesian statistics aims to solve; the former concerns the possibility of inferring hidden causes from observed effects. Hacking argued that both problems depend on the emergence of probability but in different ways. All that the analytic problem needed was the concept of internal evidence that came in degrees. From the Port Royal *Logique* (1662) to Bernoulli’s *Ars conjectandi* (1713) to Laplace’s *Théorie analytique des probabilités* (1812) and beyond, the solution to the analytic problem became a prime desideratum of probabilists. But, Hacking continued, the sceptical problem required an additional conceptual ingredient to become conceivable. In the scholastic philosophy of *scientia*, causes in natural philosophy had in principle been demonstrable. Indeed, until the seventeenth century, mathematical demonstrations had also been subsumed under the causal sort.⁶ Causality therefore belonged to knowledge worthy of the name. For Hume, however, causes could no longer be demonstrated and had been demoted to the category of mere probability—but probability now understood as a degree of internal evidence, not as the old *opinio*. Hacking concluded: “It is clear why the sceptical

⁵ John Locke, *An Essay Concerning Human Understanding* (1689), ed. Peter H. Nidditch (Oxford: Oxford Univ. Press, 1979), 4.15–16, pp. 654–668.

⁶ Paolo Mancosu, *The Philosophy of Mathematics and Mathematical Practice in the Seventeenth Century* (New York: Oxford Univ. Press, 1996).

problem of induction requires a transformation in *opinio*: without that, there is no concept of internal evidence about which to be sceptical” (p. 181). For Hume, there is no necessary connection between cause and effect, and the accumulation of internal evidence that would make such a connection ever more probable depends on the assumption that the future will be like the past, which is the very proposition the tally of internal evidence is supposed to prove. The circle closes with a click, which Hacking took to be the end of his story about signs, evidence, and probability: “Cause and effect—the paragon of the old knowledge that was demonstration—and signs, the purveyors of opinion, have become one. . . . Causes are signs, but signs suggest the things signified [according to Hume] ‘only by an habitual connection’” (p. 183).

This is a very condensed account of that part of Hacking’s book that was heralded by the title and that has attracted the most critical responses since 1975. Hacking briefly addresses some of these criticisms in the 2006 introduction, acknowledging especially the force of claims made by Daniel Garber and Sandy Zabell that concepts of internal evidence of just the sort Hacking claimed had catapulted the new concept of probability into existence circa 1660 could be found centuries earlier in ancient works of rhetoric and divination.⁷ But for the most part, Hacking does not seem, thirty years later, to have been much daunted by his critics—and with good reason: they have largely adopted his terms of framing of the problem, “the emergence of probability,” even if they have not embraced the surprising specifics of his solution or the bold generalities of his approach.⁸ Moreover, although Hacking’s audacious thesis about the utter novelty of concepts about probability and internal evidence naturally attracted the most (and the most combative) attention, the bulk of his book was devoted to close readings of the cluster of late seventeenth-century texts that flagged the emergence of probability in all its two-faced glory: the Port Royal *Logique* on external and internal evidence, Pascal’s wager, Christiaan Huygens on games of chance, John Graunt and William Petty on mortality statistics, Jan de Witt on annuities, John Arbuthnot on the argument from design, Jakob Bernoulli’s limit theorem, and, above all and throughout, Gottfried Wilhelm Leibniz as curious, contemplative, and (in his own weird way) contributing witness to the whole proceedings. Hacking’s analyses have been nuanced and contextualized by subsequent research on this or that text, but they still reward the reader, beginner or old hand, with a harvest of insights to be found nowhere else.

Thanks in large part to Hacking’s work, both *The Emergence of Probability* and the companion volume on later developments, *The Taming of Chance*,⁹ the history of probability and statistics is booming, and not just in the history of mathematics: historians of biology explore the origins and impact of statistical notions of population; political and

⁷ Daniel Garber and Sandy Zabell, “On the Emergence of Probability,” *Archive for History of Exact Science*, 1979, 21:33–53. The excellent new translation of Jakob Bernoulli’s *Ars conjectandi* by Edith Sylla, with informative notes to medieval sources, had not yet appeared when Hacking wrote the 2006 introduction: Jakob Bernoulli, *The Art of Conjecturing together with “Letter to a Friend on Sets in Court Tennis,”* trans. with introduction and notes by Edith Dudley Sylla (Baltimore: Johns Hopkins Univ. Press, 2006).

⁸ In the meantime, however, important book-length studies relevant to one or another aspect of Hacking’s thesis have appeared. On signs and divination see Jean Céard, *La nature et les prodiges: L’insolite au XVIIe siècle*, 2nd rev. ed. (Geneva: Droz, 1996); and Ian Maclean, *Logic, Signs, and Nature in the Renaissance: The Case of Learned Medicine* (Cambridge: Cambridge Univ. Press, 2002). On the book of nature see James J. Bono, *The Word of God and the Languages of Man: Interpreting Nature in Early Modern Science*, Vol. 1: *Ficino to Descartes* (Madison: Univ. Wisconsin Press, 1995). On reading see Ann Blair, *The Theater of Nature: Jean Bodin and Renaissance Science* (Princeton, N.J.: Princeton Univ. Press, 1997). On induction and early modern experience more generally see Peter Dear, *Discipline and Experience: The Mathematical Way in the Scientific Revolution* (Chicago: Univ. Chicago Press, 1995).

⁹ Hacking, *Taming of Chance* (cit. n. 4).

social historians chart the insatiable appetite of modern states for statistics about every aspect of citizens' lives and deaths; historians of rhetoric examine the complex interaction of statistical and anecdotal argument in political discourse; sociologists study how the insurance industry came to put prices to the most diverse risks, from the failure of the wheat crop ten years hence to the loss of the life of a child. Along with Foucault's theses on biopower,¹⁰ Hacking's work made probability and statistics visible, ubiquitous, mighty, and sometimes ominous.

The trajectory of the kind of history Hacking used to plot the rise of the probabilistic behemoth is more difficult to plot. In the early 1990s I tried to put a name to it, historical epistemology,¹¹ and cited Hacking (by then writing about what he called "making up people"¹²) and the philosopher Arnold I. Davidson¹³ as leading practitioners. This seems to have caught on in some quarters¹⁴ and, for what it's worth, continues to animate my own interests in the history of entities like facts or objectivity or observation. But the label sat uncomfortably with Hacking himself (he gently satirized it as "historical meta-epistemology," a term too teutonically polysyllabic to suggest any clear and distinct ideas to the mind of the well-trained analytic philosopher¹⁵). After examining the debates between scientific realism and social constructionism from several fresh angles (including the philosophy of experiment),¹⁶ Hacking took up the term "historical ontology" to describe how, particularly in the human sciences, new kinds of people become possible, instantiating categories such as multiple personality disorder or autism or fugue.¹⁷

Yet despite these shifts in subject matter and terminology, the distinctive lineaments of Hacking's brand of history have persisted. First and foremost (and here the debt to Foucault is most evident), it is a history of novae: big, dazzling new stars suddenly exploding into the firmament of concepts. Second, and still more Foucauldian, the concepts in question are not the sorts of things that have traditionally been supposed to have birth and death dates. Just as Foucault's work on the history of sexuality inspired numerous studies of the history of ideas and practices so entrenched as to appear inevitable, Hacking's study of the emergence of probability unsettled the self-evidence of what had seemed to be the most established philosophical concepts: what could be more self-evident than evidence? Third, and here Hacking begins to part ways from Foucault, who notoriously refused to brook questions about why epistemic ruptures occurred when and where they did, the past

¹⁰ Michel Foucault, *The History of Sexuality*, Vol. 1: *An Introduction*, trans. Robert Hurley (New York: Pantheon, 1978), pp. 138–146. See also Hacking's discussion in "Biopower and the Avalanche of Printed Numbers," *Humanities in Society*, 1982, 5:279–295.

¹¹ Lorraine Daston, "Historical Epistemology," in *Questions of Evidence: Proof, Practice, and Persuasion across the Disciplines*, (ed. James Chandler, Arnold I. Davidson, and Harry Harootian). (Chicago: Univ. Chicago Press, 1991), pp. 282–289.

¹² Ian Hacking, *Rewriting the Soul: Multiple Personality and the Sciences of Memory* (Princeton, N.J.: Princeton Univ. Press, 1995).

¹³ Arnold I. Davidson, *The Emergence of Sexuality: Historical Epistemology and the Formation of Concepts* (Cambridge, Mass.: Harvard Univ. Press, 2001).

¹⁴ See, e.g., Mary Poovey, *A History of the Modern Fact: Problems of Knowledge in the Sciences of Wealth and Society* (Chicago: Univ. Chicago Press, 1998).

¹⁵ Ian Hacking, "Historical Meta-Epistemology," in *Wahrheit und Geschichte: Ein Kolloquium zu Ehren des 60. Geburtstags vom Lorenz Krüger* (ed. Wolfgang Carl and Lorraine Daston). (Göttingen: Vandenhoeck & Ruprecht, 1999), pp. 53–77.

¹⁶ Ian Hacking, *Representing and Intervening: Introductory Topics in the Philosophy of Natural Science* (Cambridge: Cambridge Univ. Press, 1983); and Hacking, *The Social Construction of What?* (Cambridge, Mass.: Harvard Univ. Press, 1999).

¹⁷ Ian Hacking, *Historical Ontology* (Cambridge, Mass.: Harvard Univ. Press, 2002).

is legible, albeit only with effort and acumen, in present concepts. Fossilized in modern notions of probability are the clues that guide the historian to the all-important prehistory that sets the stage for the mutation. Although sharp breaks slash through Hacking's conceptual history, they are presaged (though not predicted) by unexpected alignments of extant elements, such as testimony and signs. Fourth, nodding to Crombie and withdrawing still further from Foucault, Hacking's novelties emerge, but they don't submerge. Rather, styles of reasoning¹⁸ accumulate, unfolding within the space of possibilities ordained by the stars that attended their birth. Fifth, although some variation does occur as concepts age, the consequential history is over almost as soon as it began: thereafter, concepts do not so much develop as repeat themselves. "In the past 300 years there have been plenty of theories about probability, but anyone who stands back from the history sees the same cycle of theories reasserting itself again and again" (p. 15). All significant history is prehistory.

Let us neutrally call this the "history of emergences." In its foci and rhythms it is strikingly unlike most history of science currently being written. It is not hostile to context (Hacking is adept at providing a flash of local color about the Roannez circle or early modern state policies on pricing annuities), but neither is it about context: for the most part, the texts, canonical texts at that, command center stage. Hacking is a scrupulous reader, with a strong sense of the otherness of the past, but he does not hesitate to translate seventeenth-century ideas into modern parlance. Pascal's wager is parsed in terms of decision theory; Bernoulli's "golden theorem" is rendered in current notation. Hacking's attitude toward his historical actors is endearingly reminiscent of that which Clifford Geertz ascribed to the great British anthropologist E. Evans-Pritchard¹⁹: however outlandish the beliefs of another people may seem (e.g., those of the Azande on witchcraft), these strangers ultimately navigate by the same matter-of-fact, rational principles as one's neighbors in Oxford or Cambridge. Conversing with Leibniz might be a bit bewildering for both parties at first, but eventually mutual comprehension would be achieved. Whereas readers of Foucault enjoy the frisson of imagining the likes of Renaissance mathematician, astrologer, and physician Girolamo Cardano as inhabiting the conceptual world of a Martian, and (at the other extreme) readers of much history of philosophy are encouraged to regard Kant as no different than the colleague down the hall, only a great deal smarter, readers of Hacking stretch a neighborly hand across the centuries to grasp that of a stranger but still a fellow human.

What use is the history of emergences? Followers of Foucault have emphasized the emancipatory potential of his brand of history: to show that past attitudes and axioms about, for example, sexuality have been wildly different from today's assumptions is to open up a window of possibility for change in the present. As I have already noted, Hacking too fleetingly gestures toward the possibility that history may unlock present conceptual cages. But at least two further requirements must be met. First, the utopian potential for things to be otherwise is not enough; actual alternatives—whether to current views on the nature of sexuality or of probability—must somehow be generated. Creative metaphysicians of the stamp of a Leibniz are rarer than creative poets of the stamp of a Milton; mutations of the sort posited by Hacking are presumably rarer still. Second, and still harder

¹⁸ See Ian Hacking, "'Style' for Historians and Philosophers," *ibid.*, pp. 178–199.

¹⁹ Clifford Geertz, "Slide-Show: Evans-Pritchard's African Transparencies," in *Works and Lives: The Anthropologist as Author* (Stanford, Calif.: Stanford Univ. Press, 1988), pp. 49–72.

to fulfill, the alternatives must be livable. What is notably missing from Foucault, Hacking, and almost all other scholars tilling these vineyards is some account of how what was once a breathtaking novelty—an “invention,” as so many book titles in this vein trumpet—assumes a self-evidence of its own, so that it is only with a mental wrench and a sense of wonder that we can imagine that it could ever have been otherwise. What practices (if practices are indeed the mechanism) cement and banalize what was originally shocking? The history of emergences abounds with the pleasures of the new and the counterintuitive. But we still lack a history of how novae fade into commonplaces: a history of self-evidence.