Vignettes: Obscurer Vices

It would be fascinating to have a study of the after-lunch alcohol content of the American workforce, and of the variations in productivity, work quality, and safety that accompany variations in drinking short of actual drunkenness. Such a study would be expensive and technically difficult, which is one reason it has never been attempted. Another reason is that it would weaken the identification of the alcohol problem with "alcohol abuse and alcoholism" by paying attention to the costs of nonproblem drinking.

—*Mark A. R. Kleiman*, in *Against Excess: Drug Policy for Results* (Basic Books)

Private discourse . . . grew cruder in the decades after World War II. One 1969 study of actual use of language, for example, showed that a group of adults in a leisure setting used *damn* and a four-letter word for excrement more frequently than they did *the* or *and*.

—*John C. Burnham*, in *Bad Habits: Drinking, Smoking, Taking Drugs, Gambling, Sexual Misbehavior, and Swearing in American History* (New York University Press)

third-person singular agreement suffix *-s* to agree with its subject *Noam*. This is head marking, because the verb is considered the head of the sentence. But in "muchas gracias," the dependent word *muchas*, "many," is marked with a feminine plural suffix *-as* so as to agree with the head word *gracias*, "thanks"; this is dependent marking. Nichols assigns scores to languages depending on which type of morphological marking they favor.

Nichols argues that this feature is of typological importance, that it shows considerable stability, and that its geographical distribution is not random. For example, New World languages tend to mark heads more than dependents, whereas Old World languages tend toward dependent marking. The Pacific region is intermediate between the two. Nichols interprets this distribution as a trace of the earliest expansion of human settlement from Africa and nearby areas to more remote parts of Eurasia and the New World.

Nichols identifies ten major structural features of this kind and investigates their patterns of distribution within a sample of 174 languages. Points of analysis include correlations among features; stability within both language families and geographical areas; evenness of distribution within geographical regions of varying sizes; and areas of maximum diversity. On the basis of such patterns (and other assumptions), Nichols sketches a general picture of linguistic prehistory, consisting of three stages: an initial development of linguistic diversity in the tropical areas of Africa and the nearby parts of Asia; an early expansion from the Old World tropics to Europe, the remainder of Asia, the Pacific, and the New World; and a third, post-glaciation stage in which more complex social groups spread their languages over large areas of the world, thereby removing much of the original linguistic diversity (which remains only in peripheral areas).

In a study involving such a large corpus, it is of course easy to find particular judgments to disagree with. For example, Nichols treats colloquial French as a verb-initial language and assumes that Mandarin Chinese has no prepositional phrases. Though both languages have indeed been analyzed this way, the analyses are certainly debatable.

A more serious problem is that many of the mathematical arguments in the book (and there are quite a number of them) do not inspire confidence. Some examples:

1) In one passage, Nichols says that in measuring the stability of certain features within language families, "two metrics are used" and that "both yield the same hierarchical ranking" of the features' stability. But the two metrics are entirely interdependent: one is the sum of the number of different types in each family for the eight families under consideration, and the other is the mean number of types per family—that is, just the first number divided by 8 (pp. 166–167 and table 52).

2) Data are sometimes inconsistent between tables (as in tables 50 and 53).

3) Nichols makes extensive use of what she calls "Dryer's test"—referring to a procedure for testing hypotheses about linguistic universals proposed by the linguist Matthew Dryer. Though there is no room here for details, her adaptation of Dryer's procedure to measure "significance of divergence" (pp. 187–188) is certainly idiosyncratic and appears to be invalid (as far as may be judged from her laconic description of it).

Of course, these problems do not prove that Nichols's conclusions are wrong: she does make a convincing case that the distribution of typological features among the world's languages is nonrandom and that this distribution may have much to tell us about linguistic—and therefore human—prehistory. Her scenario for the spread of human language must be considered preliminary, but it is not unreasonable. Her book will be a rich source of ideas and techniques for those who wish to pursue this line of investigation further.

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Mathematical Malaises

Pi in the Sky. Counting, Thinking, and Being. JOHN D. BARROW. Clarendon (Oxford University Press), New York, 1992. xii, 317 pp., illus. $25.

The Rock of Gibraltar of most mathematics, indeed of almost all reasoning, is the principle of the excluded middle. We use a two-valued logic where statements are either true or false. No middle ground is possible.

A man of Seville is shaved by the Barber of Seville if and only if the man does not shave himself. Does the Barber shave himself?

If he does he doesn't; if he doesn't he does. The statement can be neither true nor false. The conclusion: the barber cannot exist. The problem is that in a mathematical sense the barber does exist, or at least did by the permissible definitions of the turn of this century. This innocent paradox, recast by Bertrand Russell in only slightly more erudite terms, deeply shook both Russell and the foundations of mathematics. Since it is possible to deduce irrefutably the truth of anything from a contradiction, a single inconsistency in the fabric causes the entire structure to crumble. If Russell's paradox is not resolved then unicorns exist and pigs fly.

The foundations crumbled but the building stood. Mathematicians worked on, largely unimpeded by the most profound crisis imaginable in the philosophy of mathematics. (This is the usual direct impact of philosophy on mathematics.) But inexorably, over this century, the effects of a close examination of the underpinnings of math-

ematics and reasoning have in fact changed the way many of us view the world of mathematics.

A hundred years before Russell's paradox ushered in the 20th century, the great French scientist J. L. Lagrange wrote,

> It seems to me that the mine is already almost too deep, and unless we discover new seams we shall sooner or later have to abandon it. Today Physics and Chemistry offer more brilliant and more easily exploited riches; and it seems that the taste of the century has turned entirely in that direction. It is not impossible that the mathematical positions in the Academies will one day become what the University chairs in Arabic are now.

This lament echoes a *fin de siècle* pessimism that has struck mathematics toward the end of each of the last three centuries. Very likely we will indulge in a similar malaise of millennialism over the next few years. If we are as lucky as were our ancestors, this will be followed, in the manner of an economy coming out of a long recession, by a tremendous burst of productivity in which new and unexpected directions will be taken. Paradigms will shift, perhaps as dramatically as they did at the beginning of both this century (in the shadow of the modern atom) and last century (with the advent of rigor à la Cauchy and the later disquieting discovery of non-Euclidean geometries).

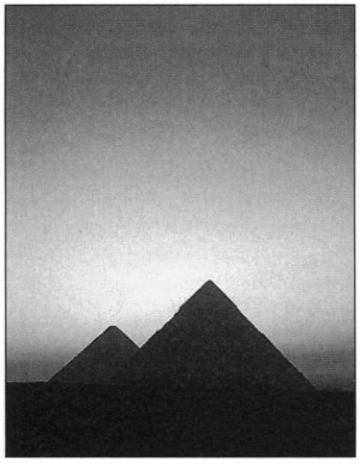
For Lagrange mathematics was prosaically Platonic, intellectual coal to be mined. The lament was not for the passing of mathematics, it was for the passing of mathematicians. Mathematical ore is still there even if no one is digging. It is the cultural loss, or perhaps the loss of a pleasant livelihood, not the lost science, that is found troubling.

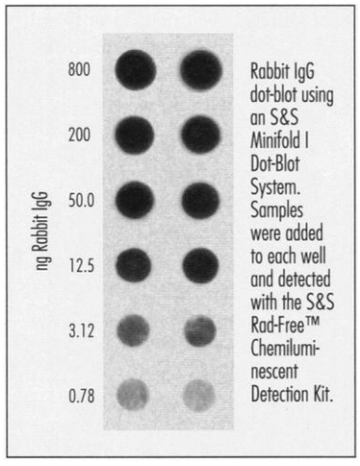
Lagrange, comfortable in his Platonic belief in a tangible, physical mathematics and its concomitant discovery and exploitation, might have been much shaken by the crisis induced by Russell and his contemporaries. Others certainly were. Many mathematicians today take a much more formalist, axiomatic, and bloodless approach to their subject. Some take an extreme constructivist position: things that cannot be constructed finitely do not exist. Others take an intuitionist point of view: proofs must eschew the principle of the excluded middle and must be fully (psychologically) analyzable.

The questioning of foundations has led to some of the truly profound insights of the century about the nature of knowledge, uncertainty, randomness and unknowability, the gulf between truth and proof. Out of the brains of logicians like Turing sprang fully formed theoretical computers—with all the power of the physical ones that were still to be built. Thus computers were in fact discovered before they were invented—or perhaps it is the other way around.

This begins to touch the themes of Barrow's richly woven book, which is really a collection of six long, lucid, loosely linked essays in the philosophy, history, and culture of mathematics.

We would not indulge in "millennialism" if we had six fingers on each hand, nor would we tend to encapsulate by centuries. But we would almost certainly still count, and quite probably in very similar fashion, even if in a different base. In a long chapter on the cultural development of counting and numeration, Barrow asserts, "The Indian system of counting has been the most successful intellectual innovation ever made on our planet"—a grand claim that is persuasively defended. The Indian innovation is primarily the number zero. A Wonderland feature, that nothing can be claimed more successful and inevitable than the discovery (invention) of nothing.





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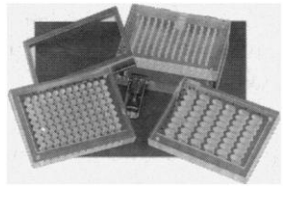

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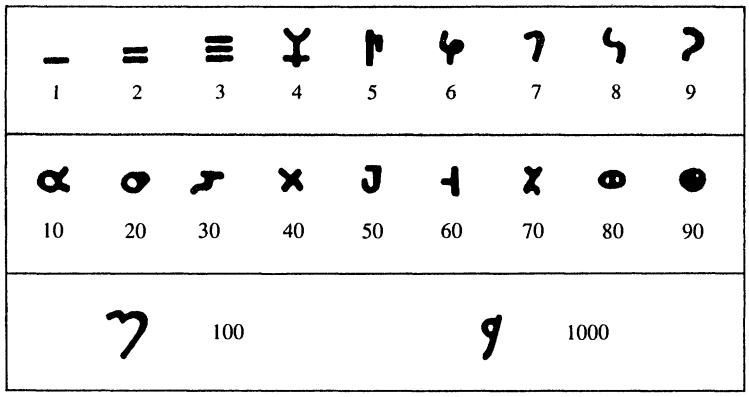

"An early form of Indian numerals in Brâhmî script. Our own number symbols are descended from them." [From *Pi in the Sky*]

Most of this book revolves around making the case for and against the various competing philosophies of mathematics. By and large the case against wins each round. It is very hard to embrace any of these philosophies wholeheartedly. We tend to set our own personal demarcations. But for most of us some parts of mathematics *exist*: natural numbers, triangles, perhaps pi. Some of the more exotic and abstract bits just don't have the same claim to a life of their own. The average mathematician is a mosaic: perhaps two parts Platonist to one part formalist, with a taste for constructive proofs when possible. (We challenge the reader to find a working mathematician of any philosophical stripe who would refuse authorship of a classically valid but nonconstructive proof of the celebrated Riemann hypothesis no matter what axiomatics that proof demanded.)

What keeps this book so readable is the texture: the historical anecdotes; the careful biographical sketches of Goedel, Cantor, Brouwer, Hilbert, and others; the excursions into the bizarre world of undecidability; the speculations on the future; the thought-provoking ripostes. (In answer to Roger Penrose, Barrow suggests that the capacity to encode undecidable statements is a precondition for consciousness of a structure.) Throughout Barrow demonstrates a remarkable scope, a fine sense of how mathematics works, and considerable insight into how it may be evolving. Occasional minor technical infelicities do nothing to mar the success of his project.

Barrow writes, "Today it is not unexpected to find the 'computer' or the 'program' as central paradigms in our attempts to interpret the Universe" and observes that "the concept of experimental mathematics has begun to take on a new and more adventurous complexion." This pervasive use of the computer to attempt to interpret mathematics rather than just the universe is surprisingly new. Mathematicians invented computers and then for several decades proceeded largely to ignore them. It is only recently, with the advent of really successful symbolic manipulation of computer algebra packages, that computers have come of mathematical age—or, more accurately, have entered puberty.

This book is not so much about mathematics as specialist subject as it is about mathematics as universal language. Talking meaningfully about mathematics without talking in mathematics is a difficult and underpracticed art. Barrow's book is a very welcome addition to this literature.

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