

mathematics. And that, for many people, is where puzzlement, if not outright phobia, sets in.

John Derbyshire, author of the elegant *Prime Obsession: Bernhard Riemann and the Greatest Unsolved Problem in Mathematics* (2003), attempts here to render non-threatening the large branch of mathematics known as algebra. Algebra began with number problems our ancestors must have dealt with. How do you allot grain fairly among families of different sizes? If one sheep's worth of wool makes a rug of a certain size, how many sheep do you need for a rug twice as long and wide? Early on, there must have been people of a mathematical bent for whom working out number puzzles was an attraction in itself. A cuneiform tablet from the Babylonians records the solution, awkwardly expressed in words, of what we would now call a quadratic equation. But lack of a handy notation hampered progress for millennia. Not until the 17th century did the familiar  $x$ 's and  $y$ 's become commonplace, and that's when algebra took off.

At first, letters stood plainly for numbers, so an algebraist could solve a problem in a general way, then answer a specific question by plugging in actual values. But true mathematicians deemed the last step uninteresting. It was the manipulation of symbols according to logical rules that caught their fancy, not the real-world applications. Soon, they realized that they could denote a certain operation—a swapping of coefficients in a cubic equation, say—by a symbol, then explore the algebraic properties and rules governing that symbol. Repeat, ad infinitum. Algebra, in this generalized sense, concerns logical relationships among abstract entities whose definitions in terms of simple numbers have been left far behind. We are in the world of fields and groups, rings and manifolds, homology and homotopy—and a strange, self-referential, infinitely fertile world it is.

Derbyshire has a witty, almost brusque way with words. He offers pithy anecdotes, sardonic asides, and sharp-eyed vignettes of his protagonists. Admirably, he doesn't talk down to readers but leads them on with breezy confidence. One

imagines a hearty, no-nonsense schoolmaster marching his pupils across the moors in a howling rainstorm, turning back occasionally to say, Come along now, it's just a bit of water, it won't hurt you!

There's no escaping the reality, however, that this is a book about algebra. Readers will be able to judge the depth of their fascination by marking the page number at which they begin to fall behind. I made it about two-thirds of the way through, but then I was trained merely as a theoretical physicist. As the concepts become more abstruse, the operations more convoluted, an urgent question presses: What's it all for?

Perhaps Derbyshire would regard the question as crass. To the mathematician, juggling esoteric concepts and searching out their abstract relationships needs no justification beyond the pure intellectual pleasure it affords. But for the rest of us, the journey becomes a bit of a slog. Derbyshire has written a charming, demanding book, but even he can't bridge the unbridgeable. Mathematics—like golf or opera—offers endless delight to some, but brings others, sooner or later, to a state of baffled exasperation.

—David Lindley

## Better Living Through Neurochemistry?

IN THE RELATIVELY NEAR future, brain science may produce all sorts of technological breakthroughs: brain scans that determine whether someone is telling the truth; tests that uncover secret urges or latent tendencies, such as a penchant for violence; pills

and other treatments to erase traumatic memories or reduce the misery they cause, as well as treatments to strengthen one's memory skills; and procedures to treat and even cure blindness, quadriplegia, epilepsy, and Parkinson's disease.

Some of the near-miraculous possibilities raise daunting questions. Should a "truth-detect-

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and Policies  
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tor,” even if it’s flawlessly accurate, be allowed in trials, job interviews, contract negotiations, family therapy? Can we prevent memory pills and the like from creating social divisions between users and nonusers, divisions likely to reflect, at least in part, wealth? Should brain sensors be used in nonmedical settings—such as offices, where they might help people communicate more efficiently with computers? Such are the questions that the nascent field of “neuroethics” aims to address.

In *Hard Science, Hard Choices*, based on a conference held in May 2005 at the Library of Congress, Sandra J. Ackerman reviews the expert opinions on these topics. Sections of the book are devoted to brain scans, brain-computer interfaces, and drugs. Throughout, she stresses two inter-related questions: What *can* we do? And what *should* we do?

Many of the technological advances offer the possibility not just of curing the ill but of improving the healthy—of making people, in the oft-heard phrase, better than well. Drugs such as Prozac and Ritalin are already being used in this way, and future medicines and implantable devices will provide more extensive possibilities. The participants are divided about the moral, political, and social challenges. Stanford Law pro-

fessor Hank Greely, for example, sees no problems with enhancement per se: “I’m a teacher; enhancement is my business.” By contrast, neurologist Anjan Chatterjee describes a disturbing scenario in which a businessman pops amphetamines to master Arabic (research on stroke victims indicates that the drugs may help people learn), while his school-aged son takes Viagra before competing in races (as Ackerman notes, it helps the lungs work more efficiently, “among other effects”). So who’s right? You won’t find conclusive answers here—the field is too new and the science too rapidly changing for that.

Ackerman’s account can be disjointed and superficial. For example, she declares without elaboration that “we can never really know whether anyone else is conscious.” (I don’t know that my wife is conscious?) Such slips may reflect the project’s genesis as a summary of oral presentations, as well as Ackerman’s presumed emphasis on trying—mostly with success—to translate medical jargon into lay terms. Though occasionally frustrating, her book provides a speedy and engaging introduction to the scientific and moral issues, as well as a chance to eavesdrop on the beginnings of a debate that’s likely to continue for decades.

—Peter Schwartz

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