The Math Gene: How Mathematical Thinking Evolved and Why Numbers Are Like Gossip

Reviewed by Allyn Jackson

The Math Gene: How Mathematical Thinking Evolved and Why Numbers Are Like Gossip
Keith Devlin
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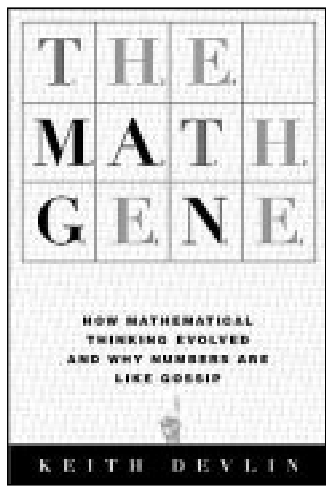
In a way it all seems so improbable. According to Devlin's book, human beings have had a recognizable concept of abstract numbers for only about 8,000 years. Mathematics as an intellectual discipline, as opposed to a collection of calculation recipes, came into being with the Greeks about 2,500 years ago. And most of what is considered higher mathematics came after the birth of the calculus less than 400 years ago. On an evolutionary scale these time spans are like flaps of a butterfly's wings. How could human brains, honed by natural selection for the basics of survival, have constructed today's mathematics in all its abstract, elaborate glory?

In this fascinating book Devlin provides a possible explanation. A well-known expositor of mathematics and frequent contributor to National Public Radio, Devlin has in recent years become interested in how the mind conceives and understands mathematics. Among his other books are *Goodbye Descartes: The End of Logic and the Search for a New Cosmology of Mind* and *Infosense: Turning Information into Knowledge*. In the current book Devlin's long experience in writing for a general audience shows in his clear and well-constructed prose, which aims always at maximal communication with the reader and never at showing off. Devlin is a cheery, patient, and unpretentious guide as he describes his theory of how mathematical ability evolved.



Devlin argues that everyone has the "math gene"—that is, everyone has an innate capacity for mathematical thinking. He defines this capacity as consisting of a number of basic attributes, including number sense, the ability to handle abstraction, a sense of cause and effect, logical reasoning ability, and the ability to construct and follow a causal chain of facts or events. The strength of these abilities may vary from person to person, but everyone has them, even those who profess to be "bad at mathematics" (the only exceptions being people with genetic abnormalities or brain damage). One might therefore view the development of mathematics as a natural outgrowth of the enormous mathematical capacity inherent in the human race.

Early in the book Devlin discusses psychological experiments and case studies that have shed light on number sense in humans and animals. Some of the case studies are quite striking, such as the tale of an otherwise intelligent young man who cannot handle numbers even in a rudimentary way, such as telling which is the larger of two numbers. Every now and again Devlin throws in a task for the reader to do to make certain points

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about the way the brain handles mathematical information. The first of these asks the reader to perform four easy subtractions: $1-1, 4-1, 8-7$, and $15-12$. Then he asks the reader to pick a number between 12 and 5. "You picked 7, didn't you?" The idea is that the brain is in "subtraction mode", so it automatically subtracts 5 from 12. In fact, the number I picked was 9. Indeed, in every one of these little tasks the result I got differed from the result Devlin predicts. These tasks therefore tended to increase my skepticism, and I found I was less persuaded by these initial chapters than I was by the rest of the book. In particular, I found myself wondering about the validity of the conclusions in some of the psychological tests Devlin describes.

The book is aimed at a general, nonmathematical audience, so Devlin devotes one chapter, entitled "What Is This Thing Called Mathematics?", to showing the reader that mathematics consists of more than arithmetic. In addition to discussing such topics as fractals and the geometry of animal coat patterns, he talks about symmetry and provides a very accessible introduction to the concept of a group. The next chapter explores the question of whether mathematicians think differently from nonmathematicians. Devlin's conclusion is that they do not but that mathematicians are more accustomed to handling abstractions.

Devlin spends a chapter and the appendix discussing linguistic theories and the idea of a "fundamental language tree" that is said to be hard-wired into all human brains. Having set up this background, he asserts that the standard account of the evolution of language, which holds that language evolved mainly to facilitate communication, is wrong. Devlin argues: "Rather it arose, almost by chance, as a by-product of our ancestors acquiring the ability for an ever richer *understanding* of the world in which they found themselves—both the physical environment and their increasingly complex social world" (page 172; emphasis in the original).

For most of the rest of the book Devlin describes how this "richer understanding of the world" evolved and how it is connected to mathematical ability and to language ability. These two abilities are usually thought to be quite separate and to be controlled by different parts of the brain. Nevertheless, Devlin argues that the two abilities actually developed in parallel. A necessary precursor for both is what he calls "off-line thinking", which is the ability to reason abstractly in a "what if?" mode. Animals can engage in quite sophisticated "on-line thinking": A chimp can look at some fruit on a nearby tree and plan a path to the fruit that avoids predators. But a chimp is not capable of planning to save some seeds from the fruit in order to plant fruit trees in a safer location. This requires off-line thinking. The ability to make such elaborate plans is one thing that sets humans apart from animals.

Devlin draws an analogy between on-line thinking and what he calls "protolanguage", a rudimentary, "me Tarzan, you Jane" communication system that lacks syntax. Off-line thinking provides a combinatorial structure connecting representations of things in the world and allows one to consider relationships between those things, how things act on other things, how certain things precede others in time, and so forth. But, Devlin notes, this is exactly the function of syntax in language. "In other words, the combinatory machinery necessary to initiate and maintain off-line thinking is nothing other than syntax," he writes (page 244). "When you get off-line thinking, you get full language, and vice versa." Devlin attributes this key insight to linguistic theorist Derek Bickerton.

In the next chapter Devlin is ready to assert that "[M]athematics is an automatic consequence of off-line thinking" (page 252). But he goes a step further to ask *why* mathematics developed. He finds the answer in a surprising place: in the predilection for human beings to gossip. The negative connotations of the word "gossip" are to be ignored here. What Devlin is referring to is the propensity of people to talk about other people, their personalities, their relationships, their activities, and all other aspects of their lives. The ability to understand the complex web of connections that link humans together was an important survival tactic in early societies. But what does this have to do with mathematics? "[A] mathematician is someone for whom mathematics is a soap opera," Devlin explains (page 261). He does, on the next page, state his main thesis a little more soberly: "To put it simply, mathematicians think about mathematical objects and the mathematical relationships between them using the same mental faculties that the majority of people use to think about other people" (page 262). Just as nearly anyone could run a marathon if he or she really wanted to, anyone could use his or her "math gene" to understand the higher realms of mathematics. The decisive factors are interest and motivation. Near the end of the book Devlin discusses some implications his theory may have for mathematics teaching.

Someone once speculated that human beings did not start using fire because they needed it for warmth and cooking but rather because they were fascinated by the flame. And the same could be true of mathematics: Human beings developed mathematics not because it was useful but because of the fascination of the structures they found. Keith Devlin's provocative and absorbing book doesn't engage in such romantic speculations, but it does resonate with them.