Overview

Mathematics is incredibly, uniquely, beautifully precise. We are used to thinking of mathematics as perfect, as the purest form of knowledge, as the foundation and the language of all the hard sciences. The human brains that we use for math, on the other hand, are anything but perfect. How could this be true? Is mathematics really made up of eternal, universal, Platonic truths? Or, as some have claimed, could it simply be a human invention, a tool or metaphor like so many others? These questions are among the greatest enigmas of science and epistemology, discussed by mathematicians, physicians, chemists, computer programmers, and philosophers. But, curiously enough, neuroscientists have been absent in the debate, even though it is precisely the field of neuroscience — which studies the brain's mechanisms for thinking and reasoning — that ought to be at the very center of these polemics. This book is a first attempt to approach this puzzle from the standpoint of neuroscience.

In order to understand what makes mathematical thinking essentially different from other types of intellectual activity, we need to first understand a few things about the neurophysiology of cognition and abstract thought in general. Most of this book is devoted to exploring those topics, in a language accessible to all readers, not just specialists.

The book provides a description of the neurophysiological mechanisms that make formal logic possible. We start in the brain cortex, where we find that there are inevitably errors in our cognitive constructs which make them an imperfect tool for feats of pure logic. Early on we address the issue of number neurons, which provide us with an innate abstract conception of numbers. Even this basic concept of mathematics, the book argues, cannot be fully precise.

There follows a discussion of the emotional and corporal aspects of abstract thought. It turns out that those aspects also play a vital role in problem-solving, at the everyday level and all the way up to the most elevated forms of abstract, heuristic thought. Neural schemes that represent our feelings and our bodies set the course for the cortex. They also steer it towards solutions to problems, and finally, presumably, they may help correct errors in the cognitive schemes that the cortex creates. The more complex and abstract the problem, the bigger a role the emotions and the body play in this process.

Different principles may govern cooperation between the body, the emotions, and the cortex. The book posits that, in the case of math, there are unique mechanisms of cooperation between the three, based on fundamental physical principles. These mechanisms help us to overcome the limitations of our physiology and allow our human brains to make transcendent mathematical discoveries.