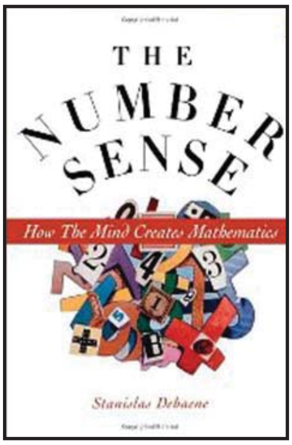
The Number Sense: How the Mind Creates Mathematics by Stanislas Debaene. New York: Oxford University Press, 1997. 288 pp. $37.95. ISBN 9780195132403.

What Stanislas Debaene dubs “the number sense” is a natural ability humans share with other animals, enabling us to “count” to four virtually instantaneously. This so-called “accumulator” provides “a direct intuition of what numbers mean” (p. 5). Beyond four, our ability to *perceive* numbers becomes approximate, though concepts enable us to move beyond approximation. Because humans typically learn number concepts in early childhood, we easily forget that our brains retain the number sense throughout life. This book examines the biological basis for this intuitive ability, with nine chapters organized into three readily graspable groups of three. Aside from its frustrating lack of a clear referencing system (making it difficult or impossible to trace Debaene’s sources), the book is a pleasure to read.

Part I examines our Numerical Heritage, focusing on animals, human babies, and adult humans, respectively. Chapter 1 recounts stories of various gifted animals whose actions suggested amazing aptitude with numbers. Debaene remains duly skeptical, noting that animals easily draw cues from human trainers informing them (perhaps inadvertently) how to answer. However, evidence from recent scientific experiments demonstrates that (for example) animals know the difference between the way numbers “add up” and the way shapes and colors operate. Some even seem to perform “an internal computation not unlike the addition of two fractions” (p. 25)! Debaene sometimes writes somewhat loosely, giving the impression that animals actually *count*, as if they possess number *concepts*. But only some primates (e.g., chimpanzees) possess such abilities—and only in laboratories, never in the wild (p. 39). His main aim, therefore, is to provide a theory of “how it is possible to count without words” (p. 28). He theorizes that the brain’s neural network represents numbers in a “fuzzy” way, enabling animal brains to approximate, whenever the given stimuli require comparison of quantities greater than four.

Debaene could have improved his argument, in Chapter 1 and throughout the book, by distinguishing more explicitly between the function of what Kant calls *concepts* and *intuitions*. The number sense involves only the latter; yet Debaene sometimes inadvertently blurs this distinction—e.g., by using the word *irrational* (p. 27) where *counterintuitive* would be more accurate. A good example of this minor weakness comes in Chapter 2: After surveying Piaget’s groundbreaking work on infant numerosity, Debaene



claims that “Piagetian tests cannot measure children’s true numerical competence” (p. 45), but does not clearly explain why. Expressed in Kantian terms, such tests measure *concepts*, not intuitions. By not making this distinction explicit, and continuing to use “concept of number” (e.g., p. 47) as if it also describes what his own impressive laboratory tests measure in children (whose details are also explained in Chapter 2), Debaene obscures the fact that his experiments *tested the intuitions* (i.e. the number *sense*) of children, including very young babies. Piaget tested children’s *conceptions*; Debaene tested children’s *perceptions*.

Chapter 3 examines historical evidence for the number sense in various ancient counting systems, then describes experiments on adults that demonstrate a clear increase in the length of time required to compare pairs of small quantities, relative to the length required to compare pairs of larger quantities. Debaene’s rather complex argument at this point could be expressed more simply, using the above-mentioned Kantian distinction: The adult human’s brain retains and continues to employ an *intuitive grasp of number* (i.e. the number *sense*!) even after the person has fully developed a working understanding of the *concept* of number. What Debaene’s experiments demonstrate, then, is that intuition works faster than conception. That his focus is on intuition, not concepts, becomes even clearer when Chapter 3 concludes with some intriguing speculations on whether numbers might possess not only spatial characteristics (cf. the “number line”), but also colors, shapes, and even sounds. Readers might remain unconvinced unless they interpret such claims as relating to non-conceptual *intuitions*.

Part II moves beyond the number sense and focuses on issues relating more properly to the concept of number as such. Chapter 4 offers a wealth of information about the language of numbers, as manifested in a wide range of cultures. Insights abound: For example, Chinese students are better at mathematics because they can count to ten using only ten syllables; and a *centi*pede has only 42 legs (100 being a conceptual approximation of the perception). Read the text itself to appreciate its rich fare! Chapter 5 complements Chapter 2 with further reflections on child numerosity, focusing this time much more on number *concepts* than on number *intuitions* (i.e. the number sense as such). Here Debaene’s text again suffers from a tendency to conflate these factors, as when he refers to children exhibiting "an intuitive understanding of what calculations mean" (p. 124). (Kantians, dry your tears!) Chapter 5 concludes by encouraging teachers to use intuition more effectively in teaching mathematics. Chapter 6, Geniuses and Prodigies, considers whether such cases arise more from special intuitive abilities, or greater conceptual rigor. In answering his (oft-repeated) question, "Where does mathematical talent come from?" (e.g., p. 170), Debaene considers a wide range of intriguing possibilities, regularly (and admirably) admitting his ignorance of any ultimate answer.

Part III, Of Neurons and Numbers, reads almost like three (interesting!) appendices. Chapter 7 reviews a range of cases where brain damage affected a person's number sense in various ways. Emphasizing the brain's plasticity, Debaene repeatedly notes that brain science still leaves much unknown territory. Chapter 8 explores numerous facts about how we *use* the brain in calculating, the brain being "responsible for almost a quarter of the energy expended by the entire body" (p. 211). Chapter 9 concludes the book with some philosophical musings on what numbers *are*. Assuming that "the human brain . . . give[s] birth to mathematics" (p. 232), Debaene insists on abandoning the computer metaphor (p. 237): "The brain is not a logic machine but an analog device." Considering numerous options from various past philosophers, he expresses frustration (p. 240) that "all our attempts to provide a formal definition [of number] go nowhere." Although Debaene might be out of his depth here, a clear intuition–conception distinction would have significantly enhanced his success in attempting to forge "a reconciliation between Platonists and intuitionists" on this issue (p. 251).

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