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Book Review

Cultural Development of Mathematical Ideas: The Papua New Guinea Studies by Geoffrey B. Saxe. New York: Cambridge University Press. 2012. xiii-362 pp.

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Body-based counting systems like the one of the Oksapmin in Papua New Guinea are widely known as unique embodied cognitive tools for numerical tasks—known not only to researchers working on numerical cognition, but also in the broader field of Cognitive Science (e.g., Bender and Beller 2012:160), and the general public. However, barely anything is known about the historical and cultural context from which these systems evolved, their properties as distributed cognitive systems, their application to daily life tasks, or their acquisition and adaptation during years of development and schooling. In this book, Geoffrey Saxe presents a body-based counting system in this very broad context, thereby providing an excellent and rich case study of numerical cognition 'in the wild.' In doing so, he highlights what the Cognitive Sciences can gain from anthropologically informed cognitive studies (as called for in the articles of Bender, Beller and Medin 2012; Whitehouse and Cohen 2012) such as deep insights into the construction and alteration of cognitive representations within the sociocultural context and its changing demands.

The book adopts a developmental perspective in two ways, first by describing the development of individual numerical competencies and, second, by combining this with a longitudinal perspective spanning two decades of sociocultural change in the Oksapmin community. These two perspectives enable Saxe to track changes in people's numerical performance both on a fine-grained, microgenetic level (synchronic analyses) and on a historically oriented, sociogenetic level (diachronic analyses). In addition, the volume also reflects the subtle transformation of the author's own scientific stance from a traditional Piagetian account, focusing on the universals in cognitive development of numerical abilities, to a culture-dependent, functional view, focusing on numerical cognition in practice and on the variability in cognitive representations.

Saxe presents a series of 18 studies from three field-trips (in 1978, 1980, and 2001) to the Oksapmin in the Mountain-Ok area of central New Guinea. The empirical material is not entirely new—in fact parts of the text originate from earlier publications—but the synopsis presented in this volume condenses a profound and impressive collection of about 25 years of research in a way that allows for deeper insights to be gained than the single papers could have done alone.

The book is organized in four parts. Part I prepares the ground for the subsequent analyses by presenting a variety of body-counting systems that are in use in the highlands of New Guinea. Also, Saxe introduces a theoretical framework of how cognition and culture interact. He suggests that we should treat these two not as separate entities, but rather as interwoven processes of individual and joint activities. Consequently, he describes changes microgenetically and ontogenetically on the individual level and sociogenetically on the group level.

By comparing cohorts of people with different economic and educational backgrounds, part II reflects the consequences of an increase in cash economy since the 1960s on number representations in terms of body-parts versus Tok Pisin and on numerical practices like quantification, addition, and subtraction, for example, in store transactions and the handling of currency tokens. The data suggests synchronic uniformity and diachronic continuity regarding the use of body-counting to support the solution of arithmetic problems, but they also suggest a great extent of synchronic variation (depending on the experience with cash economy), which is reflected in corresponding diachronic changes.

Part III is devoted to processes involved in schooling and to how collective practices in class affect the numerical representations and functions. After a brief sketch of the history of schooling in the Oksapmin area, Saxe describes how unschooled children (in 1978) developed an understanding of body-part comparisons and measurement. Children (in 1980) then adapted their body-counting strategies in school, to keep track of numerical values and to reduce cognitive load in addition and subtraction tasks. This reminds the reader of Robert Siegler's work on how “Western” children discover new strategies in finger-counting in order to make arithmetic calculations more efficient (Siegler and Jenkins 1989). Twenty years later (in 2001) after a “Western-style” school reform was put into effect in 1998, in elementary schools where the instruction language is Oksapmin, teachers continue to utilize the body-counting strategies in their lessons. However, in community schools, with English as primary language, teachers and pupils mostly rely on decimal systems, switching flexibly between English, Tok Pisin, and Arabic numerals.

In the final part IV, Saxe returns to his core theme of how cognition and culture interact in producing numerical representations and mathematical ideas. The discussion tackles three questions: *What* develops? *How* does it develop? And *why*? His answer to the first question is hardly controversial: To express mathematical ideas, people invent cultural forms of numerical representations that serve specific mathematical or practical functions. His answer to the second question is more contentious, as it builds on

the analogy of genetics that change is driven by *variation* of numerical representations, *selection* according to problem-solving goals, and *niches* of joint activities and communicative settings (e.g., in economic exchange or schooling) to which the representations are adapted. The answer to the third question may appear trivial at first glance: Mathematical ideas are developed because there is a need to be met or a problem to be solved. But Saxe's attempt to uncover the underlying regulating mechanisms digs deeper. He suggests constraints and processes on all three levels of analysis: the need for numerical and communicative coherence on the microgenetic level, individual adaptations on the ontogenetic level, and local emergence of ideas and processes of broadcasting on the sociogenetic level. This model also implies that the developmental path of a mathematical idea can lead to different directions, and that numerical representations may disappear when they are no longer practiced (cf. Beller and Bender 2008:215).

A striking commonality in the chapters throughout this book is Saxe's focus on the tool-like character of the body-part system and how this tool is used and adapted purposefully to serve new functions. No matter whether or not one shares the theoretical framework on cognition and culture with Geoffrey Saxe, his detailed analyses and the broad contextualization open a fascinating window into the cultural development of numerical cognition.

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