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Book and Film Reviews

Going from Counting to Arithmetic

The Oksapmin of New Guinea

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Cultural Development of Mathematical Ideas. By Geoffrey B. Saxe with Indigo Esmonde. Cambridge: Cambridge University Press, 2012.

Despite the title, *Cultural Development of Mathematical Ideas* is about recent changes in the cultural-cognitive representation of counting in a small community in the Oksapmin Valley of New Guinea, triggered by the introduction of Western currency and then of schools, beginning around 1960. Saxe argues that neither culture nor cognition alone suffices to account for the representation changes that occurred in this group. The book is an account of this transition that uses a mixed cultural and cognitive perspective.

Saxe first visited the region in 1978, then did fieldwork in 1980 and again in 2001. The theoretical framework he developed as part of his research deals with three interrelated processes: microgenesis, sociogenesis, and ontogenesis. The first refers to cultural and cognitive changes at the level of an individual or a dyad (e.g., individuals inventing names for coins when they were first introduced). By sociogenesis, he means community-wide processes that lead to coordination among group members and to shared understanding of, for example, the arithmetic operations involved when buying a small tin of fish from a local trader. Sociogenesis processes also feed back on microgenesis and vice versa. Finally, by ontogenesis, Saxe refers to the way objects and other artifacts may take on new functionality as the first two processes play out, with interaction among all three processes.

For the Oksapmin, an economic transaction involving addition was initially complex, because their traditional counting system does not lend itself to doing abstract arithmetic operations. The Oksapmin counted using a one-to-one correspondence of objects with body parts that extended counting on the fingers to include other body parts, but with counting seen as a bounded, rather than an open-ended, process (see below).

Their counting begins with the right pinky, then continues with the fingers of the right hand, followed by the parts of the right arm (wrist, forearm, elbow, biceps, and shoulder) and the parts of the right side of the head (neck, ear, eye), until the nose is reached; the counting continues on the other side of the body using the same body parts, but in reverse order, and finishes with the fingers of the left hand, going from the thumb to the pinky. Thus they can count up to 27 objects. When the person counting 27 objects points to her or his left pinky, she or he exclaims “*fu!*,” raising both fists into the air.

Saxe’s deciphering of the meaning of *fu* exemplifies the methodology that he used in his research. He shows that the meaning of *fu* depends on the extent to which an individual has been participating in economic and/or schooling changes by dividing the community into four groups: elders (largely outside of the economic trading and schooling that has been introduced), unschooled adults, schooled adults, and schooled adolescents. For elders, *fu* seems to mean “a complete group”; this is the response given by 65% of the elders (168). For the unschooled adults, the percentage giving this answer decreases to 50%; for the schooled adults, the percentage decreases further, to 35%; and for the schooled adolescents, it decreases to 10%, with 70% answering “don’t know.” The response “a complete group” by the elders suggests that counting is a closed, not an open, system, with the closure marked by the expression *fu*.

Saxe discusses how *fu* has also taken on the meaning of 20 in the context of English pounds and schillings. For a pound note, one points to the left elbow (“20” in the counting system) and says *fu*. According to Saxe, this appears to be a case where the meaning of *fu* has been enlarged to include the English pound, for the same reason that applies when the person doing the counting points to the left pinky and says *fu*. Here, though, the completeness has to do with British currency: 20 schillings to the pound. In terms of Saxe’s theoretical argument, the term *fu* has ontogenetically expanded its function to mark the British pound.

By subdividing the community into four groups and comparing data obtained in 1980 and 2001, Saxe gained control over the effects realized from varying degrees of exposure to and involvement in new domains, such as the economic and school domains. Overall, his research context gave him the opportunity to study “the intrinsic relations between cognitive developmental and sociohistorical processes” using a methodology that would be relevant to “other communities and with other knowledge domains” (33). Saxe’s research involves both quantitative statistical generalization and theory construction, based on data such as the processes by which the counting representation of the Oksapmin was first transformed to enable the arithmetic operations of addition and subtraction and now is being replaced by the counting system used in Tok Pisin, with its English-like words for quantities.

A problem with using body-based counting to do addition (or subtraction) arises when there are no objects to be put

in one-to-one correspondence with the body parts used in counting. If one wants to add four and five, and if objects to put into one-to-one correspondence with the body parts are not present, one can represent the idea of four by pointing to the right index finger. But now, continuing with body part enumeration to augment the quantity four by the quantity five, the person doing the counting does not know how far along the body parts the counting should continue. Saxe found that many elders simply guessed at an answer. In effect, their counting system lacked a way to keep track of counting along body parts when the objects in question are not available to index the counting. Saxe then argues that, through microgenesis and sociogenesis, ways were worked out to solve the problem of indexing the body parts when the objects being counted were not present.

Although a solution to doing arithmetic operations with the counting system was devised, it has limited utility when addition problems involve quantities greater than 27. In addition, counting systems used outside the community that are amenable to arithmetic operations began to be introduced, such as the number names in the Tok Pisin language.

Saxe comments that the Oksapmin counting system could be used to count beyond 27 by repeating the sequence. Some groups in the Oksapmin valley use a cyclic counting system based on the 27 body parts. However, the elders in the village that Saxe studies deny that they ever used cyclic counting. In addition, holding the two fists up and shouting *fu* is similar to a body part counting system used by the Paiela, a group to the northeast of the Oksapmin, who terminate the counting by holding the two hands together to make a single fist (Biersack 1982), thereby physically showing the closure of their counting system. For the Paiela, counting is by twos (hence by pairs of body parts), with the exception of the nose and the clenched fist. The nose location could also be paired if the counting used the nostrils, but the fact that they do not use the nostrils suggests two points of closure in the counting system: the nose and the clenched fists (or shouting *fu*, in the case of the Oksapmin).

In her discussion of counting among the Paiela, Biersack provides detailed information regarding the interface of the counting system with their social system, such as publicly counting the pigs given by the groom's lineage to the bride's lineage when a marriage takes place. Saxe, however, does not provide us with data on how the traditional body counting interfaced with daily life among the Oksapmin. Nonetheless, the book provides an instructive account of the way changes in cultural and cognitive systems take place.

References Cited

- Biersack, A. 1982. The logic of misplaced concreteness: Paiela body counting and the nature of the primitive mind. *American Anthropologist* 84(4):811–829.