Human Development

Cultural-Historical Analysis Done Right

Essay Review of *Cultural Development of Mathematical Ideas* by Geoffrey B. Saxe

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Geoffrey Saxe's latest book, "Cultural Development of Mathematical Ideas" takes us on a 34-year journey of research, analysis and reflection. The research reported in this book covers three periods of fieldwork in 1978, 1980 and 2001 among the Oksapmin of Papua New Guinea and an 11-year period of reflection upon the research in the writing of this book.

The Oksapmin, along with other mountain groups in Papua New Guinea, traditionally made use of a body-part system for counting – starting a count with the fingers of one hand and traversing the body to the other side (with the nose being the midpoint of the 27-body-part count). Topically, this book is about the 27-body-part counting system used by the Oksapmin and its transformation over time and circumstance. This book looks at transformations in form-function relations in the counting system occurring during a period of rapid historical change. It seeks an explanation for the change of functions of older forms and for the appearance of new forms in relation to older functions. But this is not only about form-function relationships with respect to mathematical practice and the naming of numerical quantities. It is, more profoundly, a treatment of cultural dynamics from a socio-cultural and historical point of view. Change in circumstance happens; the question is "what processes operate to change traditional systems?"

During periods prior to the research, there had been many changes in Oksapmin life where an initially isolated group experienced transformations in their life-world. The changes reflect, among other things, contact with other groups and changes in economic activities, from count to currency-based transactions in shops which involve changes in the basis for exchange from count-object correspondence to currency-based transactions. The principle is not one to one correspondence between object and quantity, but is related to the denominational value of the currency token. Not only was the shift to currency involved, but also there were three different forms of currency and political structure. First there was the base 20 pound and shilling Australian currency system, which was supplanted by a base 10 Australian dollar system,

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and then, with independence, a Papua New Guinea system roughly paralleling the structure of the dollar system but with new names. Similarly, with the shift from subsistence economy to wage-based economic activities, and to an import-export economy, currency (and its semiotic structure) entered more profoundly into Oksapmin life. In addition, with independence, there was the introduction of a "national language," Tok Pisin, that significantly differed from Oksapmin with respect to naming quantities (among other differences).

In short there were many major transformative social changes that have impacted this group from periods prior to and, in part, overlapping with the field research between 1978 and 2001. There were changes in forms of activity, in representational systems and in the function of economics and mathematics within social life, and an education system that was changing from missionary-based bible schools, to community schools, to elementary and high schools. This was accompanied in 1998 by changes in national schooling policy from teaching only in English by teachers who were not familiar with the Oksapmin language or ways of life to education reform where teachers were allowed and encouraged to use Oksapmin, Tok Pisin or English interchangeably in the classroom.

It is tempting, in the view of all these changes, to attempt to link, in a "progressive" manner, each change with a corresponding change in the cognitive characterization of the cultural group. To do so would, however, obscure the more fundamental fact that any society is made up of different historical cohorts. The fact that lives extend through time and changing circumstance suggests that the relation between synchronic and diachronic analytic perspectives is needed. This amounts to understanding that cultural groups, during periods of change, are characterized by diversity and not completely shared experiences and modes of activity.

In sharp contrast to treatments of culture-cognition relationships of the form "Culture X has form Y and is therefore Z," Saxe recognizes that cultures are not uniform X's, nor are forms Y equally distributed within a social group. Within any culture there are marked variations in age, experience, and social position in relation to change internal to and external to the cultural group. Some people are elders who may have been less involved in change and/or more rooted in the traditional ways; others may have traveled elsewhere for wage labor; some have been schooled, others not. There is greater or lesser participation in currency-based economy, and schooling itself has changed, possibly distinguishing between pre- and post-reform impact of schooling. It is, in fact, the variability within culture that is an important analytic focus, and it may be, in part (albeit speculatively), a source of developmental transformation.

The importance of recognizing within-culture variation and the problematic of cultural competence when such variation exists is at the heart of Saxe's analysis. It is what places his work at the leading edge of a new wave of cultural analysis. He places the problematic of coordinating activity in the midst of diversity at the center of focus, looking at microgenetic, sociogenetic, and ontogenetic factors as central to the analysis of cultural change and, by extension, developmental dynamics.

The research reported focuses on the use of representational systems and their semiotic properties. This is laid out in a series of experiments initially dealing with the relation between problem solution "strategies" for dealing with addition and subtraction problems and then moving on to the semiotics of body part names and their relation to currency token names and other forms of mediation.

In conducting these experiments, Saxe uses what I regard as an optimal design in terms of subject selection by combining synchronic and diachronic sampling. For example subjects are elders or plantation (or factory) returnees, "trade store owners," schooled, unschooled, etc. In this way, multiple forms of relationship to historical changes are represented: those in the currency economy, represented by trade store owners; or those involved in the wage economy or the newly emerged export economy; or those who had little contact with a currency economy represented largely by older adults, "elders"; those who were schooled (in English only or in Oksapmin, Tok Pisin and English). The relation of the language of school instruction to the language of the students has been identified as a key variable in the effectiveness and meaningfulness of schooling [Cole, Gay, Glick, & Sharpe, 1971].

In this way some of the dimensions of within-group variability are represented. These differing groups are then examined in experimental work that looks for stability or change in form-function relationships in counting, mathematical operations, and token naming. An analysis of the strategies used by group and by condition applies the logic of cognitive developmental research – vary respondents, conditions and look for differences in strategy related to these – to the case of historical-developmental or, better, cultural-historical change. The eye is constantly on changes in structure, as in reorganization of the 27-body-part counting system to accommodate the logic of currency structure – for example, seeing privileging the 20th body part as an important node in a count since it corresponds to the currency unit "pound."

In a powerful way, within-culture variability is seen as an important source of change. Despite variability in knowledge, representational form, age, etc., there is the social need to communicate, to accomplish everyday transactions across differences in knowledge systems. Sociogenetic processes such as those involved in the microgenetic, local emergence of transactional understandings, the means by which people negotiate shared understanding of what is involved, leads to within-person variability of knowledge and becomes a source, eventually, of change within society.

As a developmental model, this a refreshing departure from seeing change as always directed from the more knowledgeable to the less, or emerging only from internal dis-coordinations. The solving of the social problem of coordinating activities among those with differing experiential bases is a central analytic idea, more in this circumstance, I believe, than are "ontogenetic" processes. In developmental work with cultures that are under great socio-historical change, the problem of disentangling age from historical cohort, from transformations in schooling, etc. is critical [Cole et al., 1971]. Though admittedly speculative, the "communicative, microgenetic account" probably comes closest to an explanation of how "old forms" can acquire new functions. To coordinate across experiential distance, the familiar is used for those less experienced in the new, and, in the course of that use, it begins to take on new functions for both, either, or all of those involved in the coordinating activity. Seeing developmental change as a local emergence springing from the need to coordinate the pragmatic, socially shareable across age-related or historical change-created differences is an important next step for both a historically sensitive cultural psychology and a developmental psychology that recognizes the social and communicative in seeking to explain changes in form-function relationships.

But an explanation in terms of local emergence is not quite enough. Saxe also seeks to account for some of the factors that produce and/or amplify experiential differences. He contrasts local emergence with "broadcast" phenomena as a way of un-

derstanding how the experiential problematic is created. A more adequate picture of social life (in any society) is to look at those forces within a society that move the center of gravity in one direction or another and create the experiential gaps as society changes. Schools and teachers, economically central players, brokers, importers, exporters, political movers and shakers, colonists and independence makers – in short all those with socially respected positions – are seen as "broadcasters" of the new. While local emergence is from the local to the general or from the bottom up, broadcast is from the top down, from the outside impacting directly or indirectly on the local.

In several chapters Saxe [2012] turns his attention to changes in one broadcast form, schooling from 1980 to 2001 and the school's relation to indigenous forms of counting. He carefully documents the relation of school systems to the body count system. For example, do kids in school use body count gestures when solving arithmetic problems? In 1980 they did; in 2001 they did not. He carefully documents how, in 2001, fundamental structural features of the body count system had been rearranged so that it was unrecognizable to someone who had learned the system in 1978. Insofar as schools use overlapping representational systems (e.g., Arabic numerals, currency tokens, body part names) the coordination and interpenetration of these representational systems becomes an issue. To the extent that schools produce students who have a differing experiential base from others in society, schools are both intentional (curricular) and unintentional agents of change by creating the conditions of non-shared experiences that either contradict or are not related to socially prevalent systems that then create settings where there are needs for the solving of communicative problems. They are unintentional agents of microgenetic change by broadcasting sociogenetic transformations.

The account of form-function changes in a rapidly changing sociogenetic situation brings to mind some of the dynamics that characterize our own cultural situation. For one example, as new digital literacies emerge, the occasion for microgenetic adjustments across experiential divides increases. The Oksapmin are not alone in dealing with history, nor are we exempt. At the root of things, historical changes impact on the Oksapmin and us alike.

Historical change happens, and transformative events occur. Geoffrey Saxe's book helps us to understand how these changes play out in cultural terms. This book is a tour de force in moving theory toward a fully historical, social, and activity-based account of cultural and developmental change. The case presented is particular to an "exotic" (to us) group, but the theoretical apparatus developed has wide-ranging application. This book isn't about "them"; it is about "us" as well. It is an important contribution to developmental theory.

References

Cole, M., Gay, J., Glick, J.A., & Sharpe, D.W. (1971). *The cultural context of learning and thinking.* New York, NY: Basic Books.
Saxe, G.B. (2012). *Cultural development of mathematical ideas: Papua New Guinea studies.* New York, NY: Cambridge University Press.