

Conceptual Change:

A Cultural-Historical and Cognitive-Developmental Framework

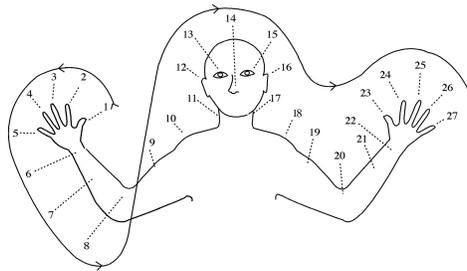
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In this chapter, I describe my approach to understanding concepts and conceptual change. I illustrate the approach's utility through the sketch of a published study on number conducted in remote and rapidly changing Oksapmin communities in Papua New Guinea, where I completed fieldwork in 1978, 1980, 2001, and 2014.

One area of marked change in Oksapmin communities is conceptual thinking related to number. Traditionally, people used a 27-body part counting system as depicted in Figure 1. Arithmetical problem solving did not emerge in traditional practices, but with the emergence of a Western currency-based economy in the 1960s, some people began to conceptualize and find solutions to arithmetical problems. In this chapter, I use the Oksapmin case to ask how conceptual changes occur in communities, like the emergence of a 27-body-part arithmetic in Oksapmin. Such a question goes to the heart of questions like, what constitutes conceptual activity and conceptual change, both for individuals as well as in the talk and action of collective life?

Figure 1. Body part positions in the Oksapmin 27-body part counting system.



A foundational assumption in my work is that concepts should be treated as processes occurring in time, rather than mental objects, a view that shares affinities with other treatments of conceptual change (e.g., diSessa, 1988; Sfard, 2008). Moreover, concepts as well as conceptual change should be understood as occurring in multiple strands that occur on multiple time scales (Saxe, 2014): over short durations, as individuals cognize and structure solutions to problems during “in-the-moment” activities (microgenesis); over extended periods of individual development, as individuals create new ways of thinking (ontogenesis); and, over durations in community life, as the common ground of talk and action is (often unwittingly) reproduced and altered in networks of interlocutors (sociogenesis). At its crux, my approach is about the interplay between micro-, socio-, and ontogenetic processes through time. To illustrate the

approach, I focus on *representational forms* used in communities, like the Oksapmin 27-body part counting system, and the *cognitive functions* like arithmetic that these forms serve in processes of micro, socio, and ontogenesis.

An Illustrative Case of Micro-, Socio-, and Ontogenetic Developments through Participation in Collective Practices of Economic Exchange

In June, 2001, en route to Oksapmin communities, I spent several days in a mining town in the highlands of Papua New Guinea along with two of my doctoral students and my 19-year-old son. Shortly after arriving, I encountered some Oksapmin people who had relocated to the town. During the unexpected reunion, the seeds of a study emerged. I thought that I heard a word form that sounded like “*fu*” used in conjunction with a body part name. I questioned people about its meaning. My interlocutors indicated that uttering *fu* after a body part meant to double the body part’s value. For me, this was a remarkable moment. In my 1978 and 1980 visits, I had documented that arithmetic using the body system was alien to Oksapmin elders. Indeed, the functions of the body system were largely about counting valuables, indicating relative spatial positions (of places on a path), or producing measurements of string bags, a common cultural artifact (see Saxe, 2014).

There was another issue about *fu* that sparked my curiosity. The word form, “*fu*” had a resonance with my earlier visits in 1978 and 1980. As captured in the woman’s display in Figure 2a, people exclaimed “*fu!*” with fisted hands erupting upon completing an enumeration of all 27 body parts. So, I wondered, was the doubling “*fu*” the same word form as the fisted *fu*? a different word entirely? If the same word, was the new use of *fu* an unrelated development to fisted *fu*? Further, if there were continuity between the *fu*’s, then a number of questions followed. First, in processes of sociogenesis how could *fu* come to carry a doubling function in the common ground of talk between interlocutors, one seeded by a fisted *fu*? Further, what might be the cognitive processes involved in in-the-moment cognitive work such that *fu* becomes a means to serve the communicative function of double? But these questions are getting ahead of the sequence of events that occurred in 2001 that led to a series of empirical studies.

Entering the Oksapmin World

After the brief stay in the mining town, we flew to a dirt landing strip in one of the Oksapmin valleys and hiked to the area in which we would reside. Not long after settling, I queried old Oksapmin friends and new acquaintances about *fu* and the origins of its doubling meaning. The direct questions revealed little. What I did learn from some older people was that *fu* in talk meant something like “a full group of plenty of things.” I took this to be a fact of interest but was unclear of its import for a sociogenetic analysis that might link the fisted and doubling *fu*’s. Then, one day, rooted in a hunch linked to my earlier visits to the Oksapmin, I

organized informal conversations with several people in which I took a less direct but ultimately more productive investigative tack.

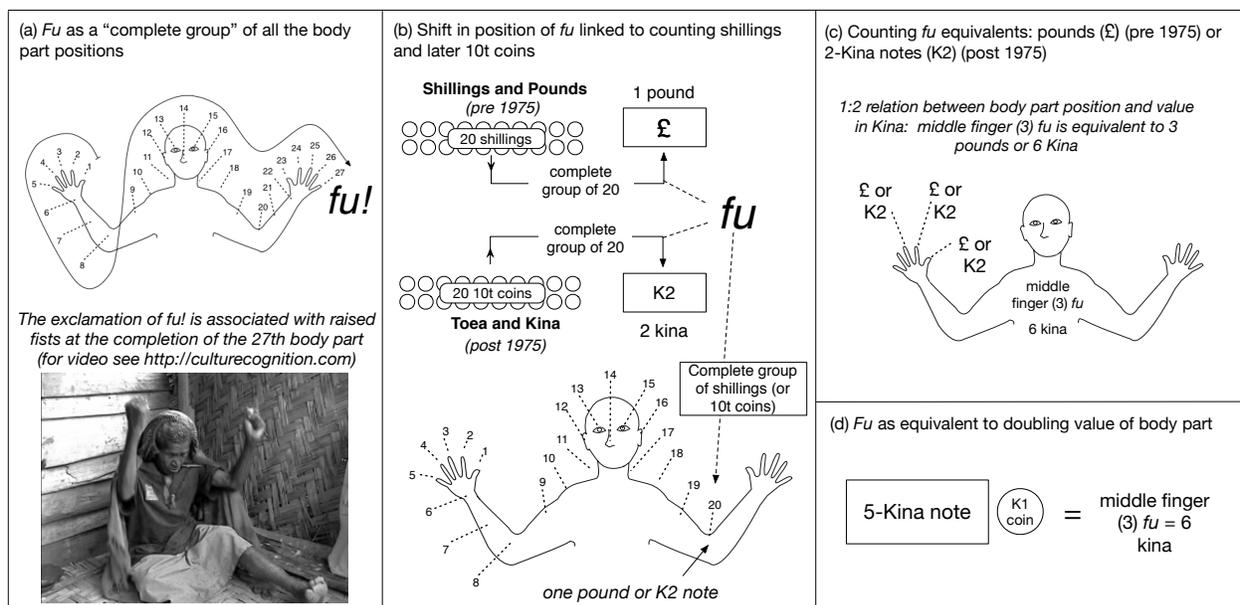
The hunch. My hunch was related to the history of currency and economic exchange in the Oksapmin area and the use of the body system to count currency units. I knew that the first Western currency to circulate in Oksapmin was the Australian pound and shilling, with 20 shillings the equivalent to one pound. Further, during my early visits, I learned that, some people used body parts only up to the elbow (20th body part position) not pinky (27th body part position) when dealing with currency. I wondered, might this 20:1 shilling-pound relation and then attenuation of the body system at elbow (20) have something to do with the emergent doubling meaning of *fu*? Further, I also knew that in contemporary practices, people referred to the 2-kina note as a “faun” (pound) and the 10-toea coin as a “siling” (shilling). The continuity in language between pounds-shillings and kina-toea preserved the 20:1 relation. Might the 20:1 relation be implicated in a shift from the fisted *fu* to doubling-body-part-value *fu*? I was puzzled and curious.

The hunch crystallized into a working hypothesis when I had the occasion to visit with three adults—an elder, an older adult, and a middle-aged adult. I thought to pose my inquiry about *fu* in a different manner than my earlier more direct questioning that solicited people’s reflections about the past. Now, I asked people of different generations about the present – with what position in the body count system was *fu* associated? The answers were provocative. I found that the elder insisted that the position for *fu* was the little finger (27); the middle-aged adult insisted that *fu* was at the elbow (20); the older adult said that it was either the elbow (20) or the little finger (27). Upon reflection and if corroborated by others, I thought that I had stumbled upon a working explanatory hypothesis that could account for the fisted-*fu* seeding a doubling *fu*.

The working hypothesis. My working hypothesis, which was refined over the course of several empirical studies, is illustrated in Figure 2 (for an elaboration, see Saxe, 2014; Saxe & Esmonde, 2005). It took the following form. If one of *fu*’s very early meanings was a “complete group of plenty” then the early use of *fu* to mark the 27th body part would seem a meaningful trope. Indeed, *fu!* could be used to refer to a complete enumeration of all of the 27 body part positions (see Figure 2a). Subsequently, in the 1960s, with the emergence of the money economy and exchanges of currency, the shift for *fu* from pinky (27) to elbow (20) could be related to the fact that 20 shillings was equivalent to a pound; thus, 20 shillings would constitute a complete group of shillings, as depicted in Figure 2b, leading to *fu* to be a completion of a count of 20 shillings at the elbow (20) or a pound, the complete group. Still later, when currency shifted to Kina and toea, a pound (or *fu*) became the equivalent of a 2-Kina note (and shillings the

equivalent of 10 toea coins). Thus, individuals could refer to three 2-Kina notes (K2) notes as middle finger (3) *fu*, the equivalent of six kina (Figure 2c). Finally, the use of *fu* to express Kina with body parts in communicative interactions may have generalized for some to a doubling function of *fu* independent of reference to counts of K2 notes. This possibility is illustrated in Figure 2d, in which a 5-Kina note and a 1-Kina coin are treated as middle finger (3) *fu* or six kina (and no longer is the reference to K2 notes a necessary intermediary in the use of *fu* to serve a doubling function.). Of course, this story is replete with speculation. But with such a working hypothesis as a guide, I could design studies that would either provide corroboration, nuance, or refutation of the contours of the sociogenetic trajectory.

Figure 2. The working hypothesis: *Fu* as shifting from (a) 27th position, to (b) the 20th position, to (c) the K2 note (post 1975), to (d) the double of a body part value (in Kina).

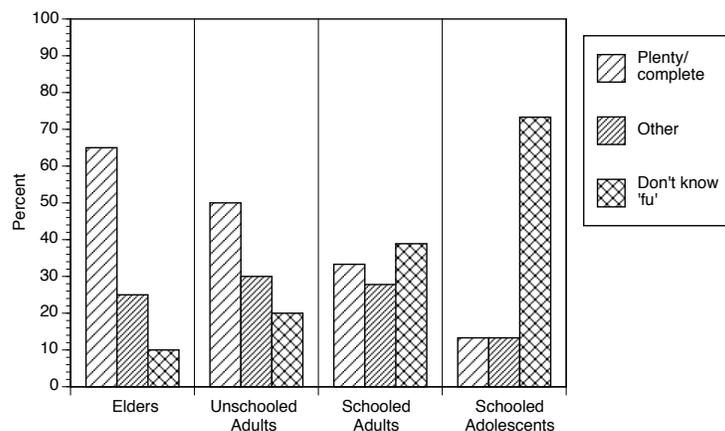


The empirical approach. My research approach was to sample multiple individuals from four cohorts (15-20 people in each cohort) that would provide a needed historical perspective. The first cohort would be steeped in traditional practices (elders), and the fourth cohort would be engaged with contemporary practices (schooled adolescents). The second and third cohorts would occupy intermediate positions on the traditional to contemporary continuum (unschooled adults, schooled adults). In my interviews with individuals from each cohort, I would focus their thinking on several questions, each of which would bear on the working hypothesis.

Question #1. *What is the meaning (communicative function) of fu in everyday talk?* To explore the everyday meanings of *fu*, we asked interviewees whether they had ever heard *fu* in talk, and if so, what it meant. As I expected, many people cited the meaning of “complete group

of plenty,” expressing the idea in varied ways. But also as expected, knowledge and use of *fu* differed over cohort. As shown in Figure 3, among the elders, people who were adults when the first missionaries arrived in the early 1960s, a majority identified *fu* as something akin to a complete group of plenty. In contrast, in the younger populations, this knowledge of *fu* was less common. Only about one half of the unschooled adults identified *fu* as something akin to “a complete group of plenty of things”; among the schooled adults and schooled adolescents, the percentage identifying *fu* with this meaning dipped to about 35% and 10%, respectively. Such findings suggest that there was a time in the not too distant past when the intensive quantifier, “*fu*,” had a meaning that was represented in a large segment of the population, “complete group of plenty of things.” But, in life today, it is diminishing, especially among the younger generations.

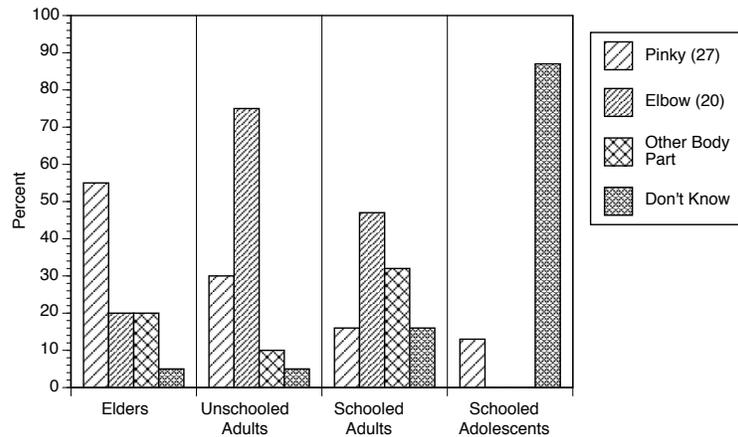
Figure 3. Percentage distribution of plenty/complete/group meaning for *fu* as a function of cohort (Figure 74 (Saxe, 2014)).



Question #2. *Where is the location of fu on the body?* Building directly upon the generational differences about positions of *fu* on the body captured in my serendipitous discussions with the three Oksapmin men noted earlier, I asked people from the four cohorts the positional location of *fu* on the body. As shown in Figure 4, I found that among the elders, many indicated that *fu* was located at the 27th body part; however, a small minority of the elders indicated that *fu* was located at the 20th and still others indicated a different body part, with only one elder indicating that they did not know the position of *fu* on the body. In contrast for schooled and unschooled adults, the modal response is that *fu* is located at the 20th position, and for the schooled adolescents the large majority indicate that they did not know the position of *fu*. These findings were consistent with my initial informal intergenerational interviews with the three adults; they corroborate the working hypothesis that there was a historical shift in the

function of *fu* from completion of 27 body parts to the completion of 20 body parts (see Figure 2b), a process linked to use of Western currencies in economic exchanges.

Figure 4. Percentage distribution of references to *fu* on body prior to probe questions as a function of cohort.



Question #3. *What is the value of fu in the selection of currency tokens?* If the 20:1 relation between shillings and pounds led to the association *fu* with a pound and then the K2 note, then one would expect the identification of the two-kina note as *fu*. To explore this conjecture, I asked individuals in different cohorts to select from an array of currency tokens that indicated *fu*. Elders and unschooled adults commonly associate *fu* with the two-kina note. In contrast, this association declined for the schooled adults and adolescents, again pointing to the connection between *fu* and pound, and *fu* and the two-kina note.

Question #4. *How is fu used in quantification practices.* As a final effort to establish corroborative support for the initial hunch, I presented people with various currency and non-currency tokens to quantify. I made use of different arrays of tokens based upon the following root values: 4, 6, 11, 21, and 29. These values were presented in the form of stones, currency of lesser value (40 toea, 60 toea, K1.10, K2.10, and K2.90) and currency of greater value (K4, K6, K11, K21, and K29), and people were asked to determine their value in the Oksapmin language (for the array of tokens constituting each value, see Saxe, 2014). We coded every time *fu* occurred in people's quantifications. Figure 5 shows that *fu* was used across the three cohorts studied – elders, unschooled adults, and schooled adults, but frequency of use varied across conditions. As revealed in Figure 5, *fu* is rarely used to quantify stones. However, *fu* is used to quantify currency of greater value, most typically K21 and K29 (and some times K11). Another feature of the findings is that the use of *fu* is not restricted to use for only collections of K2 notes. Consistent with the working hypothesis illustrated in Figure 2d, those who incorporated *fu* into

their representations used *fu* as double the value of currency rather than an enumeration of K2 notes.

Figure 5. Percentage use of *fu* by cohort, cognate value, and task condition.

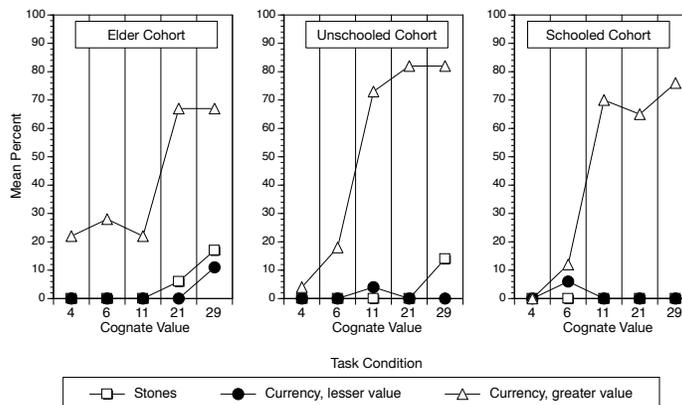
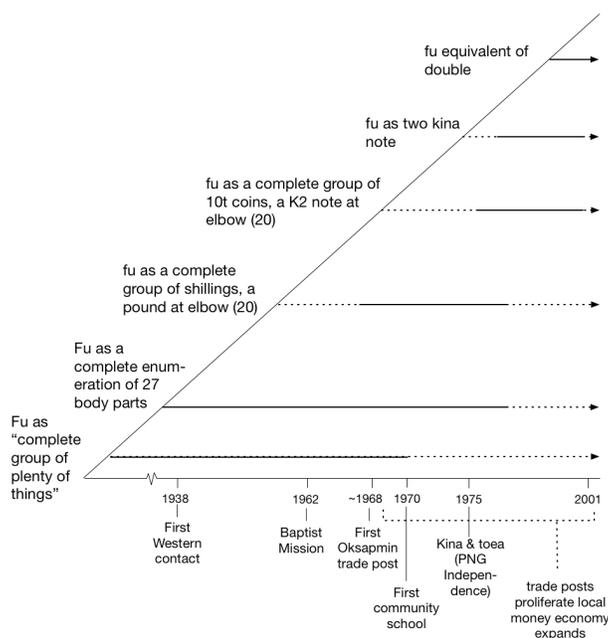


Figure 6 provides a representation of the shifting relations between the word and gestural form of *fu* and the functions that it serves over recent cultural history in the Oksapmin world. The staggered horizontal lines depict the varied functions of *fu*; the lines indicate duration of use and the bolded sections of the line segments indicate an informed speculation about the period during which a particular function was more commonly used. The figure is intended to capture shifting form-function relations (horizontal lines) in the sociogenesis of *fu* in Oksapmin communities. But it does not well capture the developmental mechanisms that led to the sociogenesis.

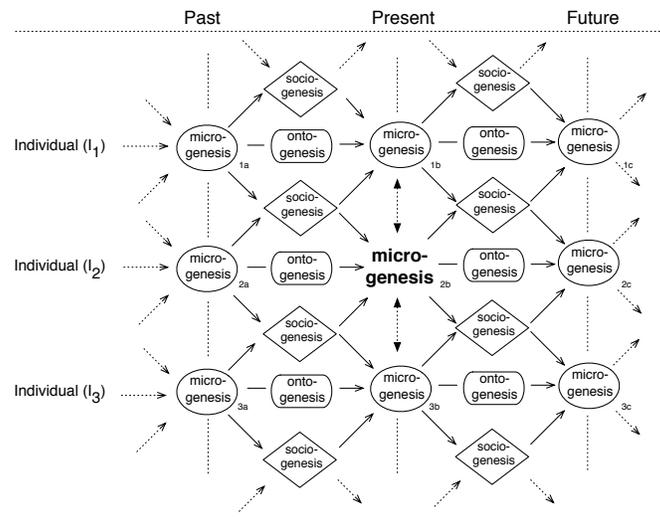
Figure 6. Shifting form-function relations related to *fu* over recent cultural history (not to scale).



A Cultural-Developmental, Cultural-Historical Framework

How might the shifting relations between cultural forms and functions shift through time in processes of micro-, onto-, and socio-genesis? Figure 7 contains a general framework that I make use of in a model of the interplay between these developmental processes rooted in human activity (see Saxe, 2014).

Figure 7. The interplay between micro, socio, and ontogenetic processes



For illustrative purposes the schematic in Figure 7 focuses on three individuals (I_1 , I_2 , I_3), in past, present, and future activities (note to adequately reflect the Oksapmin world, the figure would be constituted by thousands of individuals in overlapping networks). At the figure's center, in the present, an individual is engaged in a microgenesis of a representation such as the use of *fu* (I_{2b}); the microgenesis is a conceptual act in which the individual coordinates varied cognitive and material resources to serve problem solving and communicative functions sometimes in the back and forth interactions with others, like individuals $I_{1(b)}$ and $I_{3(b)}$. In this process, the very same microgenetic constructions also are moments in sociogenetic processes. Indeed, from a sociogenetic perspective, as interlocutors work to make their communicative intents understood to one another in microgenetic acts, they unwittingly reproduce and alter cultural forms of representation to make their communicative intents understood. The figure also reflects that the microgenetic constructions are moments in individuals' own ontogenetic trajectories in their elaboration of form-function relations, whether Individual 1 (I_{1a} , I_{1b} , I_{1c}), Individual 2 (I_{2a} , I_{2b} , I_{2c}), or Individual 3 (I_{3a} , I_{3b} , I_{3c}).

In the Oksapmin work described in this chapter, I privileged a specific form of representation, the word form *fu* and its varied functions within and across the activities of individuals over immediate and longer stretches of time. I have found this heuristic framework useful in illuminating developmental processes across a wide range of collective practices in and

out of Oksapmin communities related to understanding processes of conceptual change. Examples include analyses of candy sellers plying their trade in urban Northeastern Brazil (Saxe, 1991), young children engaged with numerical play in working and middle class home settings in Brooklyn, New York (Saxe, Guberman, & Gearhart, 1987), elementary school children engaged with play of educational games (Saxe et al., 2010; Saxe & Guberman, 1998), straw weavers in rural Northeastern Brazil (Saxe & Gearhart, 1990), as well as upper elementary children engaged with mathematics lessons in classroom communities (Saxe, de Kirby, Kang, Le, & Schneider, 2015). Across these analyses, I have worked with my students and colleagues to illuminate how individual and the collective are part and parcel to an understanding of the microgenetic, ontogenetic, and sociogenetic processes intrinsic to conceptual activity and conceptual change.

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