Comparing Cultures and Comparing Processes: Diachronic Methods in Cross-Cultural Anthropology

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If cross-cultural researchers hope to contribute to cultural evolutionary theory, methods must be developed to describe and explain cultural processes. The distinction made by Boas between historical and comparative methods limited scholarly interest in the analysis of patterned historical change. Numerous techniques have been developed to draw diachronic inferences from synchronic ethnographic data, with varying degrees of success. The use of archaeological and historical data to draw diachronic inferences similarly has had mixed results but requires fewer assumptions and allows a more direct comparison of cultural change. Shifting the unit of analysis from the culture to the event allows events to be compared with one another. A case study from the evolution of numerical notation systems shows the potential of rigorous diachronic methodologies to complement synchronic ones. Although synchronic analysis is highly useful for studying correlations between traits, diachronic analysis is far better for analyzing processes of change.

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The use of cross-cultural comparison to analyze anthropological data has virtually always focused on the culture as the unit of analysis. This eminently reasonable and extremely fruitful approach is the foundation of nearly all hologeistic cross-cultural research. One thing this perspective does not do well, however, is study diachronic processes of cultural change. This weakness is particularly striking because most anthropologists who conduct cross-cultural research are materialists and regard cultural evolution as an important guiding principle. Although cultural-evolutionary anthropology is currently unfashionable, it is quite understandable that it is more prevalent among archaeologists, who regularly study long-term cultural processes. Yet, with some notable exceptions (e.g., Peregrine, 2001, 2003, 2004), few hologeistic scientists are archaeologists. Despite the creation of the eHRAF Collection of Archaeology, archaeological data have been insufficiently employed for producing and testing hypotheses, and their full potential has not been realized because they are frequently treated in the same way as ethnographic data.

Although inferential techniques using synchronic data are useful for developing hypotheses concerning diachronic patterns, they are not the best way to analyze cultural change. Instead, archaeology's unique methodological and substantive contribution to cross-cultural anthropology is not simply providing data on past societies but allowing the direct analysis of cultural processes. Using the event of change, or cultural process, as the unit of cross-cultural analysis instead of the culture allows the testing of hypotheses developed in functional-synchronic studies. Just as synchronic data are best suited for the study of function within a culture, diachronic data are most suitable for the analysis of process. Although not without challenges, diachronic studies of events of cultural change belong in the toolkit employed in cross-cultural anthropology.

HISTORICAL AND COMPARATIVE METHODS

In 1896, Franz Boas's brief paper, "The Limitations of the Comparative Method of Anthropology," marked a watershed in

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the history of anthropological theory—and a disaster for comparative studies. In denouncing the conjectural unilinear sequences of Spencer (1876-1896), Morgan (1877), and Tylor (1871), Boas noted that such scholars often assumed without proof underlying biopsychological, geographic, or racial causes for cultural phenomena. Because a seemingly unitary phenomenon may have different origins in different societies—for instance, totem-based clans may develop either through the association of independent groups or by the fissioning of larger groups—correlations between two traits do not always indicate the operation of the same process (Boas, 1896, p. 903). This is the problem of equifinality, which arises because cultural evolution is often multilinear rather than unilinear. In fact, Boas seems to have believed that even striking cross-cultural similarities (e.g., widespread geometrical designs) were likely to have developed in each case in a completely unique manner. For Boas, then, the most important task was to reconstruct the processes by which cultural phenomena developed (p. 905). Boas called this method the "historical" method, which he explicitly contrasted with the evolutionists' "comparative" method.

Unfortunately, over the past century, historical methods have been taken by most anthropologists (both comparativists and noncomparativists) to mean "humanistic" methods, whereas comparative methods have been taken to mean "scientific" methods. Yet, at least in the early part of his career, Boas's position was not that cross-cultural patterns do not exist. He insisted, however, that such regularities could only be analyzed by reconstructing and comparing specific culture histories, and placed far too much emphasis on the uniqueness of cultural trajectories. Nor was his issue with large-scale statistical studies as a methodology; Boas himself undertook an important quantitative cross-cultural analysis of Native American folktales using the technique of "continuous-area" comparison (Boas, 1894). He did insist, however, that the best way to distinguish analogies from homologies, and to properly identify the cultural traits that could properly be compared with one another, was to identify instances of similar process. This, he recognized, was difficult to do with ethnographic data and often relied on highly speculative evolutionary reconstructions and "just-so" stories. Ultimately, finding no way to do such work, Boas, along with most Boasian anthropologists, abandoned comparativist research and came to hold that there were

few interesting cross-cultural regularities to be found. Boas was wrong in assuming that local continuous-area studies would eventually lead to broad, historically based generalizations about the human condition, and wrong that ethnographic data could produce accurate reconstructions of prehistory. His definition of historical methods inhibited progress in explaining cultural change because studies of a single region are far better at identifying cultural homologies than analogies.

In the early 1950s, a flurry of publications from social anthropologists and those influenced by them weighed in on the question, fruitfully arguing for a blending of hologeistic comparison, intensive interregional comparisons, and local field studies (Eggan, 1954; Köbben, 1952; Nadel, 1951; Radcliffe-Brown, 1951). Murdock (1965) himself argued strongly in favor of the study of particular historical sequences prior to the development of more general evolutionary theories (pp. 130-150) and, in his work on African culture history, argued that "the most productive procedure in both scientific and historical anthropology is one which combines the best in the two approaches and constantly tests conclusions in either by evidence from the other" (Murdock, 1959, p. 42). In contrast, however, Evans-Pritchard (1951) contended that in place of large-scale comparison, each episode of field study ought to be treated as an experiment testing hypotheses (of unspecified origin), whereas Schapera (1953) rejected generalizing comparisons in favor of local regional studies. The overall effect of these papers was to convince most cultural anthropologists that there was little value in statistical cross-cultural research. The "historical" won out, whereas the "comparative" went into decline.

Yet, I am unconvinced that the distinction between historical and comparative methods was ever useful. As Sanderson (1995) notes, there is no qualitative distinction between historical and evolutionary analysis, and if there are patterns in world history, these are best detected by studying those processes directly (p. 402). And, as Eggan (1954) insisted,

> Our best insights into the nature of society and culture come from seeing social structures and culture patterns over time. Here is where we can distinguish the accidental from the general, evaluate more clearly the factors and forces operating in a given situation, and describe the processes involved in general terms. (p. 755)

If we can do so, we can divorce history from historical determinism and produce a genuinely diachronic science of cultural change. To do so, however, requires a set of techniques and assumptions that differ substantially from both Boasian particularism and hologeistic comparison as each is currently practiced.

DIACHRONIC COMPARISONS USING SYNCHRONIC DATA

Because most anthropological comparativists are cultural anthropologists, most cross-cultural analyses of cultural process have been undertaken using ethnographic data. Naroll, O'Leary, and Sigelman's 1974 examination of cross-cultural anthropological literature revealed that more than 1,000 of the studies examined used primarily ethnographic data, whereas only a handful were classified as holohistorical, holoarchaeological, or holoethnohistorical (p. 3). Naroll's typology used the criterion of the discipline from which the data being analyzed were derived. This is slightly misleading, because the source of the data being examined and the object and methodology of inquiry do not necessarily overlap. Naroll's own holohistorical studies of creativity (Naroll et al., 1971) and military deterrence (Naroll, Bullough, & Naroll, 1974) are nonetheless synchronic studies because historical evidence is marshaled to treat each historical period as a static culture comparable with other cultures. I approach the question differently, looking instead at what sorts of questions are being asked and answered using a set of data, and therefore distinguish synchronic research, which describes cultures considered at a single point in time, from diachronic research, which aims to analyze processes of change.

There is no intrinsic reason, however, why ethnography cannot be used directly to produce diachronic data. Many, if not most, cultures have been restudied over the history of ethnographic fieldwork (not to mention earlier travelers' and missionaries' accounts), providing a wealth of suitable data; moreover, many ethnographers' longitudinal studies of individual cultures bear direct witness to this change. Yet, for the most part, ethnographic data have not been used in this manner in cross-cultural anthropology. Instead, cross-cultural surveys compare societies in stasis to other societies in stasis. Time-delineation, which avoids the

problem of the ethnographic present by pinpointing each culture being analyzed to a specific point or period in time, nonetheless does not permit the direct analysis of cultural processes over time (Murdock & White, 1969, pp. 329-330; Whiting, 1968, pp. 698-702). Nevertheless, several schools of comparative research have used ethnographic data, with varying degrees of success, to advance diachronic hypotheses concerning cultural change.

The best-known but most problematic form of such inference is the neoevolutionary reconstruction of cultural-evolutionary sequences undertaken by arranging ethnographically attested societies into stages on the basis of complexity (Fried, 1967; Sahlins, 1963; Sahlins & Service, 1960; Service, 1962). The cases in such studies were generally chosen nonrandomly and relied heavily on cultures in the researchers' areas of expertise (e.g., Polynesia). It is ironic that although neoevolutionary studies of culture are very good at analyzing how behavior relates to environmental and technological constraints in a given context, they are far worse at empirically demonstrating evolution. Peregrine (2001) aptly demonstrates the perils of archaeologists' uncritical acceptance of ethnographically derived neoevolutionary hypotheses (pp. 3-4). Ember and Ember (1995), on the other hand, list a considerable range of aspects of culture that have been demonstrated using synchronic cross-cultural comparison to correlate well with cultural complexity and recommend that archaeologists use these correlations to develop hypotheses (pp. 102-105). Yet, because not all traits evolve in a unilinear fashion, this very promising avenue of research is an insufficient demonstration of cultural evolution, because it does not show how these aspects of culture relate to the time dimension. Where archaeological data are used to test neoevolutionary propositions, however, much stronger inferences can be made with regard to evolutionary processes (see below).

While most Boasian cultural anthropologists rejected cross-cultural research in favor of historical research, Boas's continuous-area technique was further expanded and refined by Kroeber and his students, comparing all the societies in a region in an effort to distinguish homologies from analogies (Driver, 1966; Jorgensen, 1974, 1979a, 1979b; Kroeber, 1931, 1944, 1957; see also Gray, 1972; White, 1975). In the best-known of such studies, Driver used synchronic, statistically grounded, continuous-area,

cross-cultural studies of North American groups to demonstrate that homological explanations based on common ancestry better explained patterns of kin avoidance than analogical ones (Driver, 1966). Jorgensen (1979b) took this research the furthest, analyzing environmental and cultural-linguistic patterns in 172 cultures in western North America. Yet, Driver and Jorgensen were both quite aware that this technique does not, in fact, explain how traits came into being (Jorgensen, 1979a, p. 319). Aberle's (1974, 1984) research is similar in some regards but relies more heavily on techniques such as lexical reconstruction that require numerous assumptions about the nature and speed of change. This body of research highlights problems with hologeistic research that assumes uniform causality from correlations and shows how cultural relationship can be a good predictor of traits in a region, but it does not in itself provide a means of reconstructing cultural processes. It is unfortunate that statistical continuous-area comparison has essentially been a dormant field of research since 1980.

The most thoroughly developed technique to elucidate diachronic patterns using synchronic ethnographic data is scale analysis, or Guttman scaling, as first proposed by Freeman and Winch (1957) and advocated most vigorously by Carneiro (1962, 1968). Given a set of cultural traits and a set of societies, and ordering the societies by number of traits and the traits by frequency of occurrence, a "tribe-trait" scalogram is constructed. In some cases, strong scalar patterns will emerge. Using this data, it is possible, knowing the presence or absence of one trait in a culture, to determine whether other traits in the scalogram are likely to be present or absent. Although perfect scalograms are rare, exceptions can be used to further refine the hypothesis being examined and to explain the observed patterns. When well-constructed, scalograms are a powerful tool for elucidating unilinear trends in history, and Carneiro (2000, 2003) continues to advocate their use toward the creation of a true science of culture.

Yet, although appealing, scale analysis is not without difficulties. First, the requirement that older traits be retained to produce an accumulation of traits restricts its usefulness to the analysis of certain kinds of cumulative patterning. Tugby (1964), an archaeologist, points out that archaeological data often do not pattern in this way and that, instead, one set of traits is gradually replaced by

another set of traits, without an increase in the total number of traits present. As Sanderson (1990) notes, in a similar vein, "cultural evolution is first and foremost a transformational rather than an additive process" (p. 141). Second, although scale analysis allows one to predict the presence or absence of traits in a society given a known set of traits, it does not permit the conclusion that the traits developed in that order, because traits can be lost as well as gained. Carneiro (1968) has undertaken one diachronic test of an evolutionary scalogram (pp. 355-358) using Anglo-Saxon England as a case study. It is unclear, however, why this particular example is chosen or whether it is typical of sequences of change; this could only be confirmed by comparing a number of sequences. Peregrine, Ember, and Ember (2004) have done this work in a recent diachronic study, showing parallel developments in the cumulative development of cultural traits in eight ancient civilizations by using scalograms to study the cumulative development of cultural traits in seven regional cultural sequences. This is very promising work, but it is also subject to the problems raised above concerning the use of scalograms for measuring cultural evolution. Third, where there is true multilinearity in the data (e.g., two parallel evolutionary sequences of traits), scalograms will not capture this diversity. For instance, Maisels (1987) distinguishes "village-state" and "city-state" trajectories of political evolution, but this hypothesis cannot be evaluated using scalograms.

Finally, and most important, scale analysis does not establish that there is a direct evolutionary connection between any two traits and cannot tell us much about the process by which cultural change actually occurs, even when traits do accumulate in a unilinear fashion. For instance, I have no doubt that the sequence of traits "intentional use of fire—agriculture—writing—steam engine" will produce a perfect scalogram no matter what cultures are chosen for analysis, but this is not highly informative. It does nothing to answer the question of *how* writing develops in agricultural societies, or what other prerequisites may be needed. When the traits chosen are far closer together in terms of evolutionary complexity and more likely to be directly functionally related, the strength of the scalogram is often far less. Carneiro (1968) states the implication of this finding as a rule: "The degree of regularity in the relative order of development of any two traits is directly proportional to the evolutionary distance between them"

(p. 363). For instance, among societies having either full-time craft specialists or corvée, but not both, 58% had full-time craft specialists, whereas 42% had corvée (Carneiro, 1968, p. 362). This is near enough to chance that it is difficult to see how anyone could compare how one leads to the other. Carneiro's rule effectively prohibits archaeologists or historians from verifying functional correlations between traits likely to develop in immediate sequence to one another, because the correlations will be extremely weak. In fact, we might well restate Carneiro's rule as, "The more regular the scalogram, the less likely it is that successive traits will be directly related in an evolutionary sequence." I thus disagree with Sanderson (1990), who argues that despite their difficulties, the establishment of sequences through scalograms "provides a solid basis on which the construction of explanations of process can be built" (p. 140).

Somewhat better than Guttman scaling for analyzing diachronic relationships using synchronic data is entailment analysis, as used by White, Burton, and Brudner (1977) for examining patterns in the sexual division of labor. By examining zero and near-zero cells, they are able to produce trends rather than simply correlations; they can identify cases where, "If X, then Y," even if "If Y, then X" does not correspondingly hold true, thus producing a set of entailments. Yet, this research, although important in identifying functional constraints, does not get us very far in identifying causal chains, describing diachronic processes, or answering "how" and "why" questions, as the authors are well aware (pp. 21-22).

Ultimately, despite the wealth of techniques developed by statisticians to get from correlation to causation (cf. Jorgensen, 1979b; Naroll, 1968, pp. 244-248), there exist no well-developed techniques for describing or explaining historical or evolutionary patterns using synchronic data alone. Any synchronic technique for reconstructing cultural processes provides evidence that is more than a hypothesis, but less than an explanation. Because all such techniques rest on a set of assumptions by which inferences are made concerning past events, they are open to criticism because those assumptions are only testable using diachronic data sets (most common, archaeology or history). For any theory of cultural evolution to be validated, moreover, the how and why questions must be answered satisfactorily, not simply "in what order." To do

so, we need direct evidence concerning processes of cultural change, and then we need to compare them.

DIACHRONIC COMPARISONS USING DIACHRONIC DATA

More than a decade ago, Ruth Mace and Mark Pagel (1994) offered a significant challenge to cross-cultural anthropologists in recommending the identification of events of change within cultural phylogenies. By doing so, they argued, it should be possible to solve Galton's problem and compare related cultures by identifying episodes of independent invention of a given trait. Their proposed technique is not without problems. Cultural phylogenies are not "pure" phylogenies like those for biological species, because cultures borrow from unrelated neighbors regularly. Moreover, these phylogenies use language as a surrogate for culture in a rather arbitrary and unverifiable way. Identifying events by imposing cultural traits on linguistic families is unwarranted, not least because linguistic borrowing may be just as important a process as cultural borrowing (Costopoulos, 1998; Dixon, 1997). Mace and Pagel are well aware of many of these problems and make a strong case that phylogenetic reconstruction, although not perfect, can improve cross-cultural research. Yet, their identifications of past events of change are based on inferential reconstruction, and use assumed cultural events to analyze synchronic, functional correlations among ethnographically attested societies.

I share Mace and Pagel's enthusiasm for identifying events of change. A far better way to identify events of change, however, is to use historical and archaeological data directly, in place of linguistic and cultural reconstructions that require more assumptions—some completely untenable—about the nature and speed of change. At its most basic, a data set for diachronic comparison requires a set of cases (cultures or traits) for which data exist at two known points in time or historical periods—at minimum, then, defining an initial and final state. Sometimes, far more data may be available with regard to the process and context of change, and in other instances, a case may be examined at three or more points. Using diachronic data to reconstruct cultural processes provides far

more direct evidence of events of change, and far more contextual data about the events, than can be obtained from synchronic reconstructions. Using events of change only as a tool to better identify synchronically comparable cultures is, I think, a rather limited way to use diachronic data. Any researcher interested in demonstrating cultural change must compare events of change with one another, rather than comparing cultures or traits. Shifting the unit of analysis from a static one (the culture) to a dynamic, processual one (the event of change) is, I believe, a major methodological innovation in cross-cultural anthropology. Yet, there exists already a long tradition in historical and archaeological analysis that compares events of change directly, rather than inferentially—a body of research that awaits full exploitation and analysis by comparativists.

The highly speculative theories of Spengler (1926), Toynbee (1934-1961), and Coulborn (1959, 1966) are diachronic studies of cultural change but do not warrant serious consideration due to their serious evidentiary problems and faulty assumptions. Sorokin's (1937-1941) *Social and Cultural Dynamics* better combines qualitative and quantitative data in tracing patterns of artistic and stylistic change in numerous cultures, yet similarly, his identification of cyclical alternations between "ideational" and "sensate" societies (with intermediate idealistic periods) is questionable. Such grand historical models lack empirical rigor and explain patterns using metaphysics rather than data. Substantially more sound is the work of world-systems scholars who, rather than considering the formation of the modern world system as a singular event, compare it to similar, earlier local or regional processes and describe the formation of larger world systems out of multiple smaller ones (Chase-Dunn & Hall, 1994; Chase-Dunn & Manning, 2002; Sanderson, 1995; Wilkinson, 1992). This diachronic research combines the best aspects of event-focused contextual comparison with the breadth and emphasis on the longue durée characteristic of macrohistorical scholarship.

Numerous analyses of cultural evolution have been undertaken by archaeologists, or by anthropologists using archaeological data, using theories similar to the ethnographically based, inferential neoevolutionary models of change discussed above. These studies, however, use diachronic data to demonstrate cultural processes directly (Blanton, Kowalewski, Feinman, & Finsten,

1993; Childe, 1951; Earle, 1997; Flannery & Marcus, 1983; Steward, 1949; White, 1959). Yet, as Peregrine (2001) points out, such studies are problematic because "they are not truly controlled in the way sound cross-cultural studies are" (p. 9). Because of the small and nonrandom selection of cases used, such studies risk overgeneralization based on a few well-known cases, or of skewing resulting from nonrandom case selection. The wealth of data marshaled to analyze changes in each culture is frequently inversely proportional to the number of cultures that can feasibly be compared. Moreover, these studies are open to many of the same criticisms leveled at cultural-anthropological neoevolutionists, such as an overemphasis on similarity and disregard for difference and an excess of theorizing without empirical support.

A similar set of studies examine processes other than the evolution of cultural complexity but are not structurally different from those of archaeological evolutionists. Among the better-known of these include Tainter's (1988) study of cultural collapse, Algaze's (1993) analysis of the formation of outposts on the periphery of states, Curtin's (1984) work on intercultural trade, and Willey's (1991) analysis of cycles of regional integration and fission. Similarly, Rouse's (1986) comparison of several instances of migration is oriented specifically toward the goal of identifying general processes involved in migrations that will allow archaeologists to identify migration from material evidence. Although culture-historical in motivation, it ultimately aims to generalize from specific cases to produce a general theory of migration. A larger analysis of a particular type of event is Melko's (1973) little-known analysis of 52 societies and the social characteristics that lead periods of peace to end with the outbreak of war.

Even among anthropological comparativists, many quantitative efforts to study process have been limited in scope. Carneiro's (1969) analysis of Near Eastern and Anglo-Saxon cultural development and Erickson's (1973) study of Anglo-Saxon and Lowland Classic Maya stylistic change each use only two cases. Carneiro (1969), noting that his interpretation "invokes general principles of culture rather than particular events of history," argues that the patterns he adduces ought to apply to all societies (p. 1020). Erickson (1973), who finds that the specific cultural evolution of style follows a "lazy-S" curve pattern, notes more modestly that although he "would expect to find the 'lazy-S' more or less a universal characteristic of specific sequences," more studies need to

be undertaken (p. 158). I echo Erickson's sentiment and note that Carneiro's study requires the same sort of verification using a much larger sample.

A larger analysis of 40 Neolithic sites in the Near East uses the time dimension to show that agricultural surpluses and domestication preceded certain types of grave goods and animal figurines (Fuller & Grandjean, 2001). Although more limited in scope—not claiming worldwide generalizability—such studies show how comparative archaeological research can be used to discern and analyze events. Korotayev, Kazankov, Dreier, and Dmitrieva (2003) offer a problematic but undoubtedly diachronic analysis of changes in kinship terminology systems in the Circum-Mediterranean region by studying 18 societies, each at two points in time. The largest diachronic study undertaken by anthropological comparativists to date is that of Bradley, Moore, Burton, and White (1990), who use pinpointing not simply to specify the units being compared but to analyze the historical dimension of changes in subsistence patterns in 87 ethnographically attested small-scale societies to compare the effects of colonialism. This technique, which has not been widely borrowed, demonstrates that some kinds of ethnographic data can be used to analyze cultural processes directly.

Ember and Ember (1995) and Peregrine (2001) stress the importance of including archaeological data in hologeistic research and note that archaeologists have much to gain by developing hypotheses based on synchronic, ethnographically based studies. I agree completely. The assumption that the entirety of human variation is reflected in the ethnographic record is demonstrably false. Ethnographic data reflect the interests and methodology of ethnographers, who normally study societies using single-community field studies of limited duration (Wobst, 1978). Moreover, societies described in the ethnographic record were rarely unaffected by contact with the West prior to being studied (Ember & Ember, 1995, pp. 95-96; Jorgensen, 1979b, p. 314; Wolf, 1982). As a result, the Standard Cross-Cultural Sample (SCCS) and other samples of ethnographically attested cultures describe only a nonrandom sample of the attested variation among all known cultures, which in turn describes only a sample of *all* cultures, including those in deep prehistory about which we know almost nothing. These are powerful reasons for archaeologists to participate in cross-cultural comparison.

Even more important, however, archaeology allows more direct analysis of cultural processes than ethnography, and so plays a special role in developing and testing cultural-evolutionary hypotheses. Peregrine's recent (2001, 2004) diachronic comparisons of all the cases in the *Outline of Archaeological Traditions* use a regression analysis with Murdock and Provost's (1973) index of cultural complexity as the dependent variable and the midpoint of the tradition's time period as the independent variable, demonstrating conclusively the existence of powerful (but not exceptionless) unilinear diachronic patterning. This avoids several of the problems of scalograms and other inferential techniques and refutes the radical relativist claim that there are no trends in history. Although it is not surprising to many of us that, for instance, political integration has tended to increase over the past 12,000 years, as Peregrine (2004, p. 297) rightly notes, many anthropologists and some archaeologists reject this notion. The necessary next step is to compare sequences and processes in a rigorous fashion, establishing similarities and differences in the manner in which cultures change over time. Without such work, we know only what happened, but not how, and I suspect that both cultural anthropologists and archaeologists (not to mention historians) will be dissatisfied with mere descriptions of change.

The fact that comparisons of process are best accomplished using diachronic data is neither a critique of synchronic research in general nor a repudiation of all techniques for historical inference using synchronic data. Where diachronic, processual studies of change are used to verify the inferential, synchronic techniques currently employed in cross-cultural anthropology, the latter can be independently confirmed or refuted. Far more important than the type of data being used is the nature of the questions being asked. By asking, "What are the characteristics of a particular event of change?" and then, "What generalizations can be reached by comparing many events of change?," we can produce a diachronic science based on direct observation and comparison of cultural processes.

NUMERICAL NOTATION: A CASE STUDY

In my doctoral research (Chrisomalis, 2003, 2004), I described and analyzed more than 100 visual, primarily nonphonetic

TABLE 1
Numerical Notation Systems

Cumulative-additive	Roman numerals	MCCCCXXXIIII
Ciphered-additive	Greek alphabetic numerals	,αυλδ
Cumulative-positional	Babylonian cuneiform numerals	𒐕𒌋𒐖 𒐜𒐼
Ciphered-positional	Western (Hindu-Arabic) numerals	1434
Multiplicative-additive	Chinese numerals	一千四百三十四

representational systems for number: numerical notation systems such as the Roman numerals and the modern Hindu-Arabic numerals. This represents the universe of numerical notation systems for which adequate data exist from 3000 BCE to the present day. Each system was delineated chronologically, described in terms of its structure, and its ancestors and descendants were determined as best as possible within the limits of the evidence. This body of historical, archaeological, and ethnographic data allowed me to examine both synchronic and diachronic patterns among the world's numerical notation systems.

Analyzing the structure of each system, I classified each system according to one of five basic combinations of principles: cumulative-additive (like Roman numerals), cumulative-positional (like the Inka *quipu* or Babylonian numerals), ciphered-additive (like Greek or Hebrew alphabetic numerals), ciphered-positional (like Hindu-Arabic numerals), or multiplicative-additive (like traditional Chinese numerals). These five possibilities are shown in Table 1.

Because most systems are historically related to one another—there are only six or seven independently invented numerical notation systems—synchronic statistical comparison was not feasible. I was, nevertheless, able to outline around two dozen universals and near-universals. Severe cognitive and logical constraints restricted the variability among attested systems. Having described these synchronic regularities, I next compared events of change as described above. Using the five principles into which every attested numerical notation system falls, I identified two basic processes. *Transformation* was defined as an event in which an older system gives rise to a descendant system that uses a different basic principle. *Replacement* was defined as an event in which a system is replaced by another (goes extinct), regardless of the basic principle of either the replaced or successor systems and

TABLE 2
Comparing Events of Transformation

	Descendant's Structure					
Ancestor's Structure	*Cu-Ad*	*Cu-Po*	*Ci-Ad*	*Ci-Po*	*Mu-Ad*	*Total*
Cu-Ad	x	3	2	0	1	6
Cu-Po	0	x	0	0	0	0
Ci-Ad	0	0	x	2	3	5
Ci-Po	0	1	2	x	2	5
Mu-Ad	0	0	1	5	x	6
Total	0	4	5	7	6	22
Cu-Ci	2		Ad-Po	10		
Ci-Cu	1		Po-Ad	4		
Cu-Mu	1					
Mu-Cu	0					
Ci-Mu	5					
Mu-Ci	6					

regardless of whether there is a phylogenetic connection between the two. In basic outline, both transformation and replacement are relatively simple events—they can be identified whenever one knows an initial and a final state.

I identified 22 well-attested events of transformation of numerical notation systems from the available data, as shown in Table 2.

These data can also be represented graphically as shown in Figure 1. I add one convention to this representation, using dotted lines to represent transformations that occurred in modern ethnographic contexts (1800 CE to present).

Although 22 cases is still too few for statistical analysis, some very interesting patterns are evident. There is a very strong trend away from cumulative systems and toward ciphered and multiplicative ones, and away from additive ones and toward ciphered-positional ones. In fact, the only cases that violate this pattern—those indicated by dotted lines—are a set of relatively short-lived numerical notation systems developed in the 19th and 20th centuries in the context of contact between complex and smaller scale societies, such as the abortive Cherokee system invented by Sequoyah (Holmes & Smith, 1977). Although many numerical notation systems survive unchanged for many centuries or even millennia, all of these exceptions survived less than

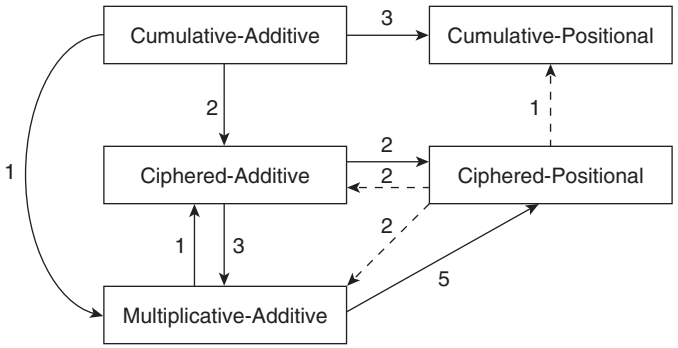

Figure 1: Transformation (graphic representation)

a century (none are in current use). I hypothesized from this fact that although transformations opposite to the overall pattern could occur, the resulting systems were extremely unlikely to be successful in competition with their ancestors and thus were less likely to be attested in archaeological or historical contexts. Overall, of the 20 possible transformations, only 10 are attested (only 7 in premodern contexts).

Turning to processes of replacement, these trends were confirmed further, as seen in Table 3.

At a statistically significant level, cumulative systems tend to be replaced by ciphered ones and additive ones tend to be replaced by positional ones. That these patterns of replacement overlap the transformational pattern discussed above reinforces a strong diachronic trend away from cumulative and additive systems like Roman numerals and toward ciphered and positional systems such as Hindu-Arabic numerals. Yet, there are also differences between patterns of transformation and patterns of replacement. For instance, whereas the transformation of cumulative systems into noncumulative ones is comparatively rare, the replacement of cumulative systems by ciphered or multiplicative ones is very frequent. Different sorts of events produce different sorts of effects, even when the overall trend is in the same direction. These patterns describe a multilinear but undeniable evolutionary sequence over the past 5000 years.

TABLE 3
Comparing Events of Replacement

	Replaced by					
Extinct System	*Cu-Ad*	*Cu-Po*	*Ci-Ad*	*Ci-Po*	*Mu-Ad*	*Total*
Cu-Ad	11	0	15	9	1	36
Cu-Po	1	0	1	4	0	6
Ci-Ad	1	0	3	19	1	24
Ci-Po	0	0	0	12	0	12
Mu-Ad	0	0	1	6	2	9
Total	13	0	20	50	4	87

	Cu	*Ci*	*Mu*
Cu	12	29	1
Ci	1	34	1
Mu	0	7	2

NOTE: $\chi^2 = 18.48$; $df = 4$; $p \leq .001$.

	Ad	*Po*
Ad	35	34
Po	2	16

NOTE: $\chi^2 = 9.17$; $df = 1$; $p \leq .01$.

My final diachronic analysis of numerical notation systems was conducted, not by comparing individual events in terms of initial and final state but by examining macrohistorical trends in the frequency of events of invention and extinction from 3000 BCE to the present day. *Invention* was defined as any event in which a new numerical notation system was created, including episodes of independent invention, transformation (described above), and the origination of new systems that were structurally similar to their antecedents. *Extinction* includes both replacement events (described above) and events in which a system ceases to be used but is not replaced. By pinpointing each event in time (just as synchronic cross-cultural studies do with cultures), then ordering the events into a single macrohistorical sequence, it was possible to determine how many numerical notation systems were in use in each century. Figure 2 shows the results of this analysis.

There is a nearly linear increase in the number of systems used between 3000 BCE and 1400 CE, followed by a drastic decline from

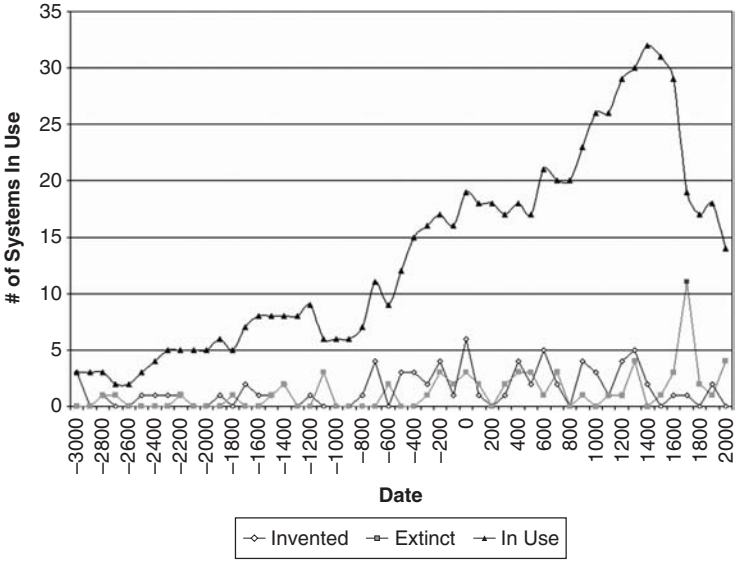

Figure 2: Trends in Systemic Invention and Extinction

1400 CE to the present day. This trend would be even more dramatic if numerical systems still used vestigially (such as the Roman numerals) were considered to be extinct. Prior to conducting my analysis, I had hypothesized that the primary cause of the extinction of numerical notation systems would be Western European colonialism and imperialism from 1800 CE to the present. In fact, however, the development of the modern world system between 1500 and 1650 CE—Wallerstein's (1974) so-called "long 16th century"—and the related spread of European commercial, scientific, and administrative practices were much more important. Whereas many cultural domains correlate positively and unilinearly with cultural complexity, variability among numerical notation systems does so only in precapitalist societies, after which the integration of all societies into the world system works to reduce the number of systems in use. Diachronic comparisons of cultural process are not limited to studying unilinear or evolutionary patterns.

The explanations of the patterns of transformation and replacement are not inconsistent with the macrohistorical analysis of

the number of systems used at any one time; in fact, they are complementary and integrated into a single social framework. My initial hypothesis was that some structural features of ciphered systems and positional systems explained why they replaced other types. Yet, if this were a complete explanation, then one would not expect a pattern such as that in Figure 2. Instead, one would expect positional systems to replace additive systems consistently and regardless of historical period. In fact, during most of the period from 3000 BCE to 1500 CE, additive and positional numerical notation systems coexisted perfectly well. Although positional systems do have certain advantages over additive ones—for instance, they are largely infinitely extendable without the need to develop new signs—these advantages are only useful in particular social contexts, such as those that emerged with the development of higher mathematics, double-entry bookkeeping, and related practices. Only when those functions became central to Western administrative practices was it highly advantageous for positional systems to replace additive ones. The trend toward ciphered and away from cumulative systems is more complex but seems to relate to a cross-cultural cognitive preference for conciseness in representation (e.g., 8 instead of VIII or even III III II).

This brief study of numerical notation demonstrates the potential of diachronic comparisons of cultural processes in combination with synchronic-functional analysis. Because each event of change is independent of every other event, statistical comparisons can be made without sampling, even though the systems themselves are related in complex cultural phylogenies (as are all cultural traits). Whereas my synchronic comparison of numerical notation allowed me to identify regularities and even exceptionless laws among numerical notation systems, adding diachronic comparison to the repertoire of techniques allowed me to identify evolutionary patterns and undertake a macrohistorical analysis based on direct evidence.

COMPARING PROCESSES OF CHANGE: ISSUES AND PROSPECTS

Diachronic comparisons of cultural processes are meant to complement, not to replace, synchronic cross-cultural studies as

currently practiced. To claim that diachronic comparison is superior to synchronic comparison would be to revive, in barely altered form, the hoary "historical versus comparative" dichotomy. I reject Peel's (1987) implication that because "their place in a time sequence is an essential feature of social facts," any nondiachronic comparison is fatally flawed (p. 109). Each method has strengths and weaknesses that should not be discounted. Synchronic studies are best suited for examining how societies function (or fail to function) and establishing patterned correlations of cultural traits, whereas diachronic studies better establish how societies change over time. Conversely, synchronic data can only be used inferentially to study processes of change, and diachronic data are not particularly well-suited to studying functional correlations. I leave open the possibility that, just as synchronic methods may complement diachronic ones for the study of process, diachronic methods may well complement synchronic ones for the study of function.

The data necessary for diachronic comparison remain in a relatively inchoate state vis-à-vis traditional anthropological cross-cultural research. Although the current eHRAF Collection of Archaeology, and the *Outline of Archaeological Traditions* being prepared by Peter Peregrine, provide a valuable and necessary counterpart to the corresponding HRAF ethnographic collection, they do not, as presently constituted, directly facilitate diachronic comparison. Because each delineated period (some encompassing many millennia) is treated as a synchronic tradition, it is difficult to use these data to analyze change. However, in some cases, two or more traditions being studied can be analyzed as part of a larger cultural sequence (e.g., Preclassic Maya → Classic Maya → Postclassic Maya). In such cases, the data exist to identify and compare processes of change. The fact that in a 2005 survey conducted by HRAF, 92% of respondents felt that the inclusion of sequences was important in the eHRAF Collection of Archaeology, whereas only 67% felt that the inclusion of randomly selected cases was important, confirms that archaeological approaches to cross-cultural research differ significantly from ethnological ones (HRAF, 2005). As the incorporation of archaeological data into hologeistic cross-cultural comparison is as yet in an early stage, no criticism of this work is intended. It is desirable, however, that as this work continues, the potential for diachronic comparison be recognized and archaeologists' inherent disciplinary interest in studying cultural processes be acknowledged.

A further objection to the comparison of cultural processes is that events of change may be much more variable than is suitable for rigorous analysis. In his study of kin terminology systems, Murdock (1949) showed that very few systems of kin terms were logically coherent and could thus survive in a stable form, but he also noted that there was considerably greater variability in the events of change by which one system changed into another. This difficulty is also embodied in anthropological linguist Joseph H. Greenberg's (1969, 1978) "state-process" analysis of linguistic change. Greenberg showed that many exceptions to universals of language were explained as unstable formations that exist only during periods of transition between stable states. If Murdock and Greenberg are correct—and I think that they may be correct for some domains but not for others, but we simply do not know at present—then the study of traits may be more productive than the study of events. But although this objection may be a criticism of diachronic comparison alone, it is, if anything, an endorsement of combining diachronic and synchronic approaches where data are sufficient. Even if the precise process of change cannot be elucidated, or if intermediate stages are quite variable, there is value in analyzing the transformation from an initial state to a final state (as in my study of numerical notation). I do not consider it to be a fatal objection.

A further issue may be that for many domains of culture, there exist insufficient cases to permit statistical analysis of events of change. In theory, any full reckoning of diachronic processes would require a database many times larger than the current material contained in HRAF, as it would need to include the additional dimension of time in addition to synchronic data. As Ember and Ember (1995) note, the use of synchronic data to test causal theories is a pragmatic choice because such tests are economical ways of studying large numbers of cases (p. 106). The limited number of cases used in most comparisons using diachronic data is a weakness, even though this research has the strength of greater contextuality of the data. My own research on numerals demonstrates, however, that for at least some cultural phenomena, diachronic tests are highly feasible and can be done in a rigorous fashion even in a single-author study conducted as doctoral research. Although this will not always be the case, it may be true more often than is currently believed. The creation of a diachronic cross-cultural

sample analogous to the SCCS may be neither feasible nor desirable. Because events separated in time are independent of one another in a manner that cultures are not, diachronic comparison of processes is less reliant on sampling than synchronic analysis.

In short, none of these objections are sufficient to negate the potential of diachronic comparisons of cultural process. Because they allow a much more direct analysis of cultural evolution (or indeed, of any cultural change) than do synchronic statistical comparisons, they ought to be part of the comparativist toolkit. Because multilinearity is characteristic of many patterns in history, diachronic data allow the comparison of sequences without assuming either a single evolutionary trend or, conversely, that no such patterns exist (Spencer, 1990). And, because diachronic data are usually historical or archaeological, diachronic comparisons invite social scientists who have previously contributed only minimally to cross-cultural research to use their data in new ways. This collaboration among comparativists is particularly vital in the case of archaeologists, whose theoretical interest in cultural evolution parallels the ability of the archaeological record to directly study cultural change. It also, incidentally, opens up an important role for historians, and anthropologists who use historical data, to play in further cross-cultural research, an orientation emphasized by Carneiro (2000) but lacking a methodological foundation that would encourage such contributions. By respecting the particular contributions of historical disciplines vis-à-vis synchronic ones, and by developing methods to test the inferential evolutionary hypotheses offered through synchronic research, we come closer to fulfilling Aberle's (1987) worthy goal of making anthropology a historical science.

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