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SCALE ANALYSIS AS AN INSTRUMENT FOR THE STUDY OF CULTURAL EVOLUTION[1]

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". . . there are stair-steps in culture change,
and the steps lead consistently upward."
—Albert C. Spaulding[2]

THE LAST DECADE has witnessed a strong resurgence of interest in cultural evolution. "Amid a good deal of tumult and shouting," Lesser has written, "social and cultural evolution have taken their place in anthropology alongside biological evolution as facts of human history."[3] That this reversal of opinion should have come about appears, in retrospect, to be not only understandable but inevitable. As White has remarked, "the concept of evolution has proved itself to be too fundamental and fruitful to be ignored indefinitely by anything calling itself a science."[4]

Modern contributions to the study of cultural evolution are still numerically small. Some of these works pick up and continue the thread of 19th century evolutionism; others break fresh ground and take up new positions. Nevertheless, most of what has been written about cultural evolution over the last decade or so is based on familiar concepts and methods. A few new techniques, notably Naroll's Index of Social Development,[5] have been devised for dealing with problems of cultural evolution, but on the whole the instruments of analysis available to us cannot be considered particularly advanced.

Perhaps one reason why progress along these lines has been slow is that most sophisticated techniques for manipulating data require the data to be in quantitative form. Data relevant to the study of cultural evolution are notoriously difficult to quantify—or at least to find in quantified form in the sources of information that anthropologists customarily employ. One partial solution to this problem would be to devise a technique for handling qualitative cultural data with a rigor ordinarily found only in quantitative methods. This, in fact, has been done. For

1 At various stages in its preparation this paper was read by David F. Aberle, Albert C. Cafagna, Bruce P. Dohrenwend, Gertrude E. Dole, Stanley A. Freed, Anthony Leeds, Raoul Naroll, Philip L. Newman, Marshall D. Sahlins, Elman R. Service, Gerald Weiss and Leslie A. White, all of whom offered thoughtful criticisms and suggestions.

2 Spaulding, 1960, p. 454.

3 Lesser, 1961, p. 40.

4 White, 1960, p. vii.

5 Naroll, 1956.

the past 15 or 20 years a group of sociologists and social psychologists have been developing a qualitative method of analysis which, although used only for the study of essentially synchronic relations so far, has all the indications of being extremely well suited to handle diachronic problems as well. Indeed, it seems to be to be a most powerful tool for the study of cultural evolution. The technique to which I refer is *scale analysis*.[6]

This paper is designed to introduce scale analysis to those anthropologists who are not familiar with it, to indicate how it might be applied to cultural evolution, and to suggest what kinds of results might reasonably be expected therefrom.

THE GUTTMAN SCALE

Several scaling techniques are used by sociologists, but the particular form of scale analysis to be considered in this paper is that known as the Guttman scale. It is so named after Louis Guttman, a social psychologist who formulated the principles underlying this scale in the early 1940's while at Cornell University.[7] The Guttman scale has been applied by Guttman himself and by a number of his colleagues and associates to a wide range of social and psychological phenomena, and they have found scaling to be characteristic of many of them. The results of their work lend confidence to the belief that scale analysis may also reveal a significant kind of order in the development of culture.[8]

EXPLANATION OF SCALE ANALYSIS

The concept of a Guttman scale is somewhat difficult to explain in abstract terms. It is however relatively easy to illustrate by means of a concrete example. For this purpose I will use an example devised from anthropological data in order to make the significance of scale analysis for cultural evolution evident at the same time that the logic of scale analysis is being elucidated.

In general, the data needed for scale analysis are: (1) a selection of items or attributes found among members of some population, and (2) a sample of units from that population. In the illustration to be used, the items will be cultural ele-

6 For introducing me to scale analysis I am indebted to Dr. Robert McGinnis, a sociologist and former colleague at the University of Wisconsin.

7 Guttman, 1944; 1950.

8 Scale analysis is not entirely new to the realm of anthropology. It has been applied to cultural data by sociologists or anthropologists in three instances that I know of (Freeman and Winch 1957; Rose and Willoughby 1958; and Mahar 1959). However, in each of these studies it was applied to synchronic rather than to diachronic problems. In none of these cases are the evolutionary implications of scaling explored, although in one of them (Freeman and Winch 1957:464-466) they are at least recognized. I also know of an article on scaling techniques written by an anthropologist (Goodenough 1944), but it does not deal with either cultural materials or diachronic problems.

ments and the units will be human societies. We will select the following eight culture traits: social stratification, pottery, fermented beverages, the political state, agriculture, stone architecture, the smelting of metal ores and loom weaving; and the following nine societies: the Kuikuru, Anserma, Jívaro, Tupinambá, Inca, Sherente, Chibcha, Yahgan and Cumaná. (These societies are all from South America only because this is the ethnographic region of the world with which I am most familiar.)

The first step in our demonstration of scaling is to indicate the presence or absence of the eight culture traits among the nine societies. This can be done most easily by constructing a table in which the traits are listed in a column along the left-hand side, and the societies are arranged in a row across the bottom. A plus (+) sign will be used to indicate the presence of a trait and a minus (—) to indicate its absence. A table showing the presence and absence of the eight traits among the nine societies, according to the available ethnographic evidence, appears as Fig. 1.

	Kuikuru	Anserma	Jívaro	Tupinambá	Inca	Sherente	Chibcha	Yahgan	Cumaná
Social stratification	—	+	—	—	+	—	+	—	+
Pottery	+	+	+	+	+	—	+	—	+
Fermented beverages	—	+	+	+	+	—	+	—	+
Political state	—	—	—	—	+	—	+	—	—
Agriculture	+	+	+	+	+	+	+	—	+
Stone architecture	—	—	—	—	+	—	—	—	—
Smelting of metal ores	—	+	—	—	+	—	+	—	—
Loom weaving	—	+	+	—	+	—	+	—	+

FIG. 1. Table showing the presence (+) and absence (—) of eight selected culture traits among nine South American societies.

An inspection of this table reveals no particular pattern to the distributions of the plusses and minuses. This is what we would expect since the traits and the societies appearing in Fig. 1 were listed in a more or less random order. The next step is to tally and record the total number of presences for each trait and the total number of traits present for each society. The results of this tabulation are as follows:

Number of Recorded Presences for Each Trait		*Number of Traits Present in Each Society*	
Social stratification	4	Kuikuru	2
Pottery	7	Anserma	6
Fermented beverages	6	Jívaro	4
Political state	2	Tupinambá	3
Agriculture	8	Inca	8
Stone architecture	1	Sherente	1
Smelting of metal ores	3	Chibcha	7
Loom weaving	5	Yahgan	0
		Cumaná	5

Now we rearrange the table presented in Fig. 1 according to the following rules: (1) arrange the culture traits in decreasing order of frequency from bottom to top so that the trait occurring most commonly is at the bottom and the trait occurring least commonly is at the top; and (2) arrange the societies in increasing order according to the number of traits they possess so that the society with the smallest number of traits will be at the left-hand end of the table and the society with the greatest number of traits will be at the right-hand end. When Fig. 1 is rearranged in accordance with these two rules we obtain the table shown in Fig. 2, which is known as a *scalogram*.

	Yahgan	Sherente	Kuikuru	Tupinambá	Jívaro	Cumaná	Anserma	Chibcha	Inca
Stone architecture	−	−	−	−	−	−	−	−	+
Political state	−	−	−	−	−	−	−	+	+
Smelting of metal ores	−	−	−	−	−	−	+	+	+
Social stratification	−	−	−	−	−	+	+	+	+
Loom weaving	−	−	−	−	+	+	+	+	+
Fermented beverages	−	−	−	+	+	+	+	+	+
Pottery	−	−	+	+	+	+	+	+	+
Agriculture	−	+	+	+	+	+	+	+	+

FIG. 2. Scalogram showing the pattern formed by the presences and absences of eight selected culture traits among nine South American societies when arranged according to the rules of manipulation.

It is immediately evident that, unlike Fig. 1 in which the +'s and —'s were distributed haphazardly, Fig. 2 manifests a definite pattern. This pattern has the appearance of a regular series of stair-steps and constitutes what is known as a *perfect scale*. If a set of items plotted against a sample of units from some population can be made to arrange themselves in this way by following the aforementioned rules, that set of items is said to be *scalable*. If a set of items cannot be made to assume this stair-step pattern—or a reasonably close approximation to it—those items are not scalable. It must not be thought that the emergence of a scale is simply an artifact of manipulation. Scaling as an attribute is either inherent in the data or it is not. Rearrangement of the traits and societies according to the stipulated rules merely brings it out; it does not and cannot create it.

FORMAL PROPERTIES OF A SCALE

If the items under consideration do constitute a scale, then a number of propositions automatically follow. Stated in terms of societies and culture traits specifically, the more important of these propositions are:

(1) Societies of higher rank order on the scale have all the traits of societies of lower rank order, and some in addition. Thus, for example, the Inca have all the scale traits the Jívaro do, and others besides.

(2) If we know a certain trait to be present in a society, we also know that certain other traits will be present as well. Thus on the basis of the scalogram in Fig. 2 we can say that if a society in our sample has social stratification it will also have loom weaving, fermented beverages, pottery and agriculture.

(3) If we know that a certain trait is absent from a society, then we know that certain other traits will also be absent. Thus we can infer from the scalogram that if a society in the sample lacks social stratification it will also lack the smelting of metal ores, the political state and stone architecture.

(4) If we know the "cut-off point" for a society, that is, the highest ranking trait it has along with the lowest ranking trait it lacks, we can deduce the society's complete inventory of scale traits, both positive and negative. This means that from a knowledge that the Jívaro have loom weaving but lack social stratification we can infer that, in addition, they have fermented beverages, pottery and agriculture, and lack the smelting of metal ores, the political state and stone architecture.

(5) If we know the number of scale traits a society has we know exactly which ones they are. Thus, if we are told that a society in our sample has three traits, we know they will be agriculture, pottery, and fermented beverages.

One can hardly overemphasize the power of the inferences that the existence of a scale permits one to make from a minimum of information. The presence or absence of a single trait enables one to draw inferences about the presence or absence of many more. Striking as this principle may at first appear, it is by no means novel. Indeed, it has been implicit in the thinking of anthropologists since the days of Tylor. If a trained anthropologist unacquainted with scale analysis knew nothing about a society except that it was ruled by a divine king, he could nonetheless list a considerable number of traits he would be reasonably sure the society would also have. By the same token, told only that a society lacked agriculture, the same anthropologist could proceed to list many other traits he could be fairly certain the society lacked as well.

DIFFERENCES IN THE PROFILES OF PERFECT SCALES

In order to make scale analysis easily comprehended the scalogram shown in Fig. 2 had the following characteristics: (a) the number of societies was almost equal to the number of traits; (b) no two societies had exactly the same traits nor the same number of traits; and (c) each society differed from the one immediately above or below it in rank order by the presence or absence of a single trait. None of these characteristics is a necessary attribute of a perfect scale. A scalogram may have a different profile from that represented in Fig. 2 and still be perfect. Figure 3, in which the "risers" and the "treads" are of varying heights and lengths, constitutes such a scalogram. If we study this scalogram in the light of the five characteristics of scaling cited above we will see that in every respect it is a perfect scale.

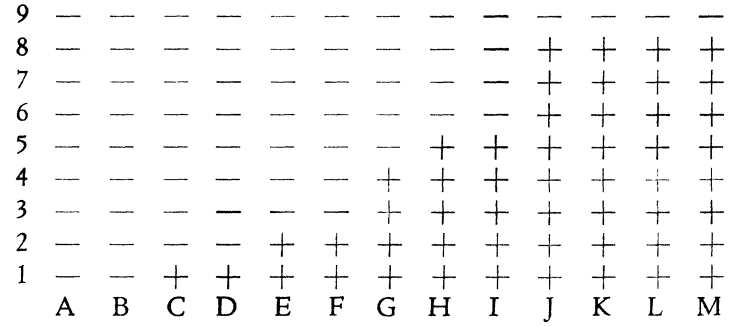

FIG. 3. Scalogram drawn from hypothetical data to illustrate perfect scaling but having a profile different from the one in Fig. 2. The numbers along the left-hand side represent traits, the letters along the bottom designate societies.

Nonetheless, there are obvious differences between Figs. 2 and 3, and these differences are revealing and instructive. One of the features in which the two scalograms differ is in the number of "types" of societies represented. (A "type" is a set of societies having exactly the same inventory of scale items.) No two of the nine societies shown in the scalogram in Fig. 2 had the same number of traits, and therefore each society constituted a separate and distinct type. In Fig. 3, on the other hand, although 13 societies are represented, only six types of societies appear, since several societies coincide in the scale items they possess.

It is readily apparent that the number of societal types appearing on a scalogram will depend on the number of societies in the sample and on the differences in cultural content among these societies. But it is also true, although less obvious, that the number of societal types depends on the number of scalable items employed. The larger the number of traits used in a scalogram, the likelier it is for the societies to be differentiated into a fairly large number of types. Conversely, the smaller the number of traits employed, the more likely it is that societies will clump together here and there on the scalogram and thus produce fewer types. Thus, had we used 20 instead of nine traits in Fig. 3, we might have obtained the maximum number of societal types possible with 13 societies, namely, 13. And had we eliminated, let us say, loom weaving and fermented beverages from Fig. 2 we would have collapsed the number of societal types from nine to seven, the Kuikuru, Tupinambá and Jívaro being merged into one.

THE MEASUREMENT OF DEGREES OF SCALING

For simplicity of exposition our discussion up to this point has been based on the assumption of a perfect scale. But perfect scales are seldom encountered regardless of what phenomena are being investigated. In order to obtain the one appearing in Fig. 2 only a limited and carefully selected number of traits and societies were used. If we were to increase the number of items or societies on this scalogram we would undoubtedly begin to find deviations from perfect scaling. In fact, it is not difficult to think of instances of societies that would fail to fit in nicely on this scalogram. For example, the Marquesans had social stratification but not loom weaving, while the Hopi have stone architecture but lack social stratification.

However, nothing worthwhile is to be gained by casting about for exceptions merely to prove that they exist. Everyone knows they do: "Perfect scales are not to be expected in practice."[9] The scientific problems at issue are, first, to determine how near an assemblage of traits and societies comes to being a perfect scale, and secondly, to decide how close an approximation to a perfect scale we can accept as

9 Guttman, 1944, p. 140.

demonstrating a significant degree of regularity. Sociologists who have worked with scale analysis have developed several techniques for measuring the degree to which a scale approximates perfection. The best known of these indexes is called the *coefficient of reproducibility*.[10] Guttman describes this statistic in the following way:

> The amount by which a scale deviates from the ideal scale pattern is measured by a coefficient of reproducibility. This coefficient is simply a measure of the relative degree with which the obtained . . . distribution [of +'s and −'s, indicating presences and absences] corresponds to the expected . . . distribution of a perfect scale.[11]

The coefficient of reproducibility obtains its name from the fact that it measures the degree to which we can reproduce or predict *which* items a member of the population will have if we know only the *number* of items it possesses. In order to calculate this coefficient we first determine the number of items whose presence or absence would have been incorrectly predicted from a knowledge of each member's scale score alone. These errors are added, and their sum is then divided by the product of the total number of items multiplied by the total number of members of the sample appearing on the scale. The resulting decimal fraction, subtracted from 1, gives us the coefficient of reproducibility. Coefficients will range between 0, which indicates no scaling at all, and 1.0, which indicates perfect scaling.

To make this procedure clearer let us calculate the coefficient of reproducibility of the hypothetical scalogram shown in Fig. 4. The number of "errors" in the scalogram is determined as follows.

We note that Society D has three scale traits. Now we would expect that if a society in this scalogram had three traits they would be Traits 1, 2 and 3. However Society D has Traits 1, 3 and 4. Thus it lacks Trait 2, which it was expected to have (one error), and has Trait 4, which it was not expected to have (one error), for a total of two errors. Society F, with five traits, lacks Trait 4 which it was expected to have, and has Trait 6 which it was not expected to have; total errors, two. Society G, which has six traits, lacks Trait 3 and has Trait 7; two more errors. Finally Society J, having a total of nine traits, should have Trait 7 but does not, and has Trait 11 which it should not have; again, two errors. The total

10 Since the coefficient of reproducibility was first devised several other indexes have been proposed, each purporting to overcome certain of its alleged shortcomings. However, in view of the fact that the application of scale analysis to cultural phenomena has hardly begun, the problem of deciding among the various suggested indexes can be disregarded for the present, and the use of the better-known coefficient of reproducibility adopted.

11 Guttman, 1950, p. 77.

	A	B	C	D	E	F	G	H	I	J	K	L	M
12	−	−	−	−	−	−	−	−	−	−	−	−	+
11	−	−	−	−	−	−	−	−	−	+	−	+	+
10	−	−	−	−	−	−	−	−	−	−	+	+	+
9	−	−	−	−	−	−	−	−	−	+	+	+	+
8	−	−	−	−	−	−	−	−	+	+	+	+	+
7	−	−	−	−	−	−	+	+	+	−	+	+	+
6	−	−	−	−	−	+	+	+	+	+	+	+	+
5	−	−	−	−	−	+	+	+	+	+	+	+	+
4	−	−	−	+	+	−	+	+	+	+	+	+	+
3	−	−	−	+	+	+	−	+	+	+	+	+	+
2	−	−	+	−	+	+	+	+	+	+	+	+	+
1	−	+	+	+	+	+	+	+	+	+	+	+	+

FIG. 4. Scalogram designed to help illustrate how the coefficient of reproducibility is calculated. The data are hypothetical.

number of errors is therefore eight. This number gives us the numerator of the fraction whose denominator is obtained by multiplying the total number of items on the scale, 12, by the total number of societies, 13. Thus we have:

$$\text{Coefficient of reproducibility} = 1 - \frac{8}{12 \times 13} = .949$$

Those who employ scale analysis in other social sciences seem to agree that a coefficient of reproducibility of .90 or above represents "an acceptable approximation to a perfect scale."[12] I see no reason why the same standard should not be used in evaluating the results obtained by applying scale analysis to cultural data. On this basis, we would say that the scalogram in Fig. 4 qualified as manifesting a significantly high degree of scaling.

THE EVOLUTIONARY SIGNIFICANCE OF SCALING

So much for the formal properties of scales and for techniques of measuring scalability. Let us now examine some of the consequences and implications of scaling in culture. We cannot of course *assume* that scaling exists in culture. Scalability cannot be posited; it must be demonstrated. But we can assert that if scaling does exist, the procedures of the Guttman scale will reveal it. Nevertheless, in anticipation of the possibility that a certain body of cultural elements will be

12 *Idem.*

found to scale there is no reason why we cannot proceed to consider what this fact would indicate about the behavior of culture over time.

We have seen that the nine South American societies scaled in Fig. 2 differed from one another by having greater or lesser numbers of the same body of traits. Furthermore, we saw that a society immediately above another in rank order differed from it in having all the traits of the latter, plus one more. The temporal implications of these facts are, first, that when societies become more complex they do so by a cumulative process which involves adding on traits of successively higher rank order at the same time that they retain traits of lower rank order, and secondly, that in this process societies add on the same scalable traits in the same order.

The view with which scaling confronts us is this: cultural evolution is essentially a single grand process in which all societies partake in much the same way, but in which they have partaken to varying degrees.[13] The analogy of a series of stair-steps, suggested earlier, is particularly useful here. From the point of view of scaling, cultural evolution appears to be a process in which mankind, in the form of individual societies, ascends a flight of stairs the steps of which correspond to a series of ranked culture traits. The order of the steps is fairly well fixed and is essentially the same for all. One must begin with Step 1 before he can proceed to Step 2 . . ., and must attain Step 9 before advancing to Step 10. Although everyone ascends in the same manner not everyone proceeds at the same rate. Accordingly, at any point in time individuals (societies) may be seen standing on almost every step, and several on the same step.

UNILINEAR EVOLUTION AND SCALE ANALYSIS

The reader may immediately recognize the picture of evolution just presented as bearing a striking resemblance to "unilinear" evolution, a brand of evolutionism which for decades has been discredited and denounced. Even the most thoroughgoing of contemporary evolutionists appear to have little interest in resuscitating the concept. Nevertheless it seems to me that unilinear evolution was rejected too quickly and too completely.

Certainly no one would contend that there is any sequence of cultural develop-

13 Curiously enough, Franz Boas, who throughout most of his academic life was known for his antagonism to theories of cultural evolution, once expressed in very succinct form the kernel and core of the idea of scaling in culture. In a passage in *The Mind of Primitive Man* Boas wrote: "If it can be shown that certain industries [he was speaking here specifically of archeological remains] occur exclusively in connection with other simpler ones and the latter alone, the former never without the simpler ones, it seems likely that the simpler type of work is earlier." And, he adds: "If this should not occur with absolute regularity, still with sufficient frequency, we might speak of *recognizable tendencies of development*" (1938:181-182; emphasis mine).

ment to which *all* societies have adhered in *every* particular. But may there not be an evolutionary sequence which *most* societies have followed *most* of the time? And would it not be of scientific interest and significance to discover and exhibit such a sequence? Efforts toward this end were hindered in the past by the belief that it was more noble to discover the exception which refuted a universal sequence than it was to construct a sequence to which a preponderant number of cases adhered.

Our attitudes, however, appear to be changing. Whereas a generation ago Goldenweiser triumphantly proclaimed that "no anthropologist today believes in an orderly and fixed procession of cultural development,"[14] an increasing number of anthropologists nowadays would be more inclined to ask: "What degree of order and regularity can we find in the development of cultures?" In scale analysis we have a tool which permits us to reexamine the question of unilinear evolution in a more comprehensive and systematic manner than has ever been attempted before. It would not surprise me if such a reexamination led to the resurrection and rehabilitation of unilinear evolution in some tempered and discriminating form.

It should be added though that unilinear evolution in the form in which scale analysis might reveal it would not be the same thing as unilinear evolution in the "classical" sense. The traditional conception of unilinear evolution (or at least that imputed to it by its critics) is that in their development *all societies go through the same stages*. Going through stages, however, means transcending or outgrowing one stage in the process of attaining the next. Thus in classical unilinear evolution there is *supersedence* of earlier forms instead of retention of them. This conception is clearly at variance with that which underlies scaling, namely, that along with the development of new forms there is retention of old ones. But despite this formal difference, the two concepts have a core of important similarities. Both hold that there is a discernable order to the way in which all societies develop, and that this order is substantially duplicated by all societies if and as they evolve.

THE CONCEPT OF A NORMAL COURSE OF DEVELOPMENT

We have already discounted the possibility of finding perfect scaling in culture. But it is not impossible that we may discover a sizable body of cultural elements which, matched against a broad sample of human societies, would yield a coefficient of reproducibility of .90 or better. If this turned out to be the case, the order of cultural elements on the resulting scalogram would represent what could be called a "normal course" of development in human society. This "normal course" of development would be quite analogous to the concept of a "main se-

14 Goldenweiser, 1925, p. 19.

quence" in stellar evolution, a notion which has come to assume a position of considerable importance in contemporary astronomy. As with stars, some societies would show deviations from the normal course, but this fact would not negate—and should not be allowed to obscure—the existence of such a course.

The exceptions and deviations which would reveal themselves need not deter us from the pursuit of regularities. Such a procedure seems to me perfectly reasonable and defensible. After all, we can legitimately focus our attention on preponderances rather than peculiarities. As a matter of fact, scale analysis should permit us to determine what is central and basic to cultural evolution, and to distinguish from it what is only peripheral and idiosyncratic.

THE BASIS OF SCALING

A question to which we have only alluded hitherto but which now demands our attention is why the phenomenon of scaling should occur in culture at all. One of the principal reasons for it is the fact that, as anthropologists repeatedly assert, culture is *cumulative*. Cumulation is the addition of new traits accompanied by the retention of old ones. We can represent this process symbolically in the following manner:

$$S_{t_1} = a$$
$$S_{t_2} = a + b$$
$$S_{t_3} = a + b + c$$
$$S_{t_4} = a + b + c + d,$$

where S is a society, t_1, t_2, t_3 and t_4 are successive periods of time in its history, and a, b, c and d are culture traits. Since societies retain many of the traits they have invented at different stages in their past, it is evident that to an important degree a society's culture history is *encapsulated within itself*. Scale analysis seizes upon this fact and attempts to make the most of it.

There are certain properties of scaling, however, that are not explained by cumulation. Why, for example, should the sequence of development be a-b-c-d rather than, let us say, c-b-d-a? And why should the order of development of these traits be the same for almost all societies?

In order to account for these manifestations we must make use of another principle of explanation, that of *functional prerequisiteness*. This principle amounts to something more than the familiar concept of functional dependence, which states merely that x depends on y, and y depends on x, in some reciprocal and synchronic manner. Functional prerequisiteness implies that x *necessarily precedes* y, which is to say that y cannot come into existence without the prior existence of x.

Note that the principle does not state that *y* must follow *x*. It may and and it may not. If the stimuli required for cultural evolution to occur are absent, societies may stagnate indefinitely and never advance beyond Trait *x*. The principle of functional prerequisiteness does not say that societies *have* to evolve. It stipulates only that if in a given society Trait *x* is followed by another scalable trait, it will be followed by Trait *y*.

That functional prerequisiteness is more than just a logical principle and actually does exist in culture would, I think, be generally acknowledged by anthropologists. Instances readily come to mind of culture traits whose existence is contingent upon the prior existence of some other trait: terracing must be preceded by agriculture, towns by villages, phratries by clans, monarchy by chieftainship, priests by shamans, money by barter, tribute by warfare, the plow by the hoe, paved roads by dirt trails, and so on.

THE SAMPLING OF SOCIETIES FOR SCALE ANALYSIS

Having examined the theoretical basis of scaling, we may now turn our attention to practical considerations involved in applying scale analysis to cultural evolution. Although logically the selection of traits might perhaps precede it, let us discuss first the sampling of societies since it is more easily disposed of.

In order to demonstrate scaling, it is not essential to use a perfectly random sample of societies. If scaling really exists in culture, any but a very small or very biased sample will exhibit it. Nevertheless, if we are to draw statistically supportable inferences about the universe of human societies from our limited sample, then it would be necessary that the sample be random. A simple random sample, however, may not be an ideal one, for we want to be sure to represent as much of the range of cultural complexity as possible. To achieve this end a stratified sample may be more appropriate.

THE SELECTION OF TRAITS FOR SCALE ANALYSIS

In taking up the problems of trait selection we must keep our stated objective in mind. Our aim is to determine which traits (if any) out of the universe of cultural elements actually scale. It is not our purpose to discover whether or not scaling is characteristic of a random sample of culture traits. Consequently, we need not try to select such a sample. For the sake of economy in fact we would do well to select only traits which seem to have some initial probability of scaling. Traits we have reason to think will not scale should be disregarded. This procedure may at first strike one as illegitimate, since it amounts to eliminating unfavorable cases

and retaining only favorable or potentially favorable ones. But it is perfectly valid given our expressed aims and objectives.

If one were still to go ahead and submit a random sample of culture traits to scale analysis the result would probably be a scalogram whose profile showed some approximation to a set of stair-steps, but whose coefficient of reproducibility would be well below .90. This result appears likely since a random sample of traits could be expected to contain some traits that would scale and others that would not. Those traits capable of scaling would produce something like a stair-step profile, while the nonscaling traits, which would show a more or less random distribution of plusses and minuses on the sccalogram, would blur its outline.

The next step would be to eliminate those traits that did not scale and to look for additional ones that did. We would do well therefore to forget about random sampling, and to direct our attention from the outset to developing rules of thumb for helping us to pre-select traits that are particularly good candidates for scaling.

Scalable culture traits have both of the following characteristics: (1) their presence indicates a greater degree of complexity than their absence, and (2) once developed they tend to be retained, if not indefinitely, at least over long periods of time.

Some culture traits manifest both these criteria unequivocally. Agriculture, metallurgy, the state, wheeled vehicles, cities, markets, stone architecture, and coined money, to cite only a few, are traits whose presence undeniably indicates a higher degree of complexity than their absence. They are also traits which societies almost invariably retain once they have developed them.

There are however many other traits which do not manifest these criteria in so clear-cut a manner. Head deformation, clans, and cannibalism, for example, are traits whose presence at a certain point in culture history indicates greater cultural complexity than their absence. But they are also traits which appear to be relatively short-lived, tending to be abandoned or replaced by societies at some later stage in their evolution. Consequently we can argue that among more advanced societies the absence of head deformation, clans, and cannibalism betokens a higher culture level than their presence. In a study of cultural evolution that carried only through intermediate levels of culture, traits such as these might discriminate nicely between lower and higher levels of society. But if we mean to examine the evolution of culture over its entire range, or at least to follow it through the rise of pre-industrial civilization, then we would expect these traits not to scale and therefore might just as well eliminate them from the start.

Certain other traits, of which the incest taboo and a belief in personal souls

may be taken as examples, present a different problem. Unlike the cultural elements just mentioned, once the incest taboo and a belief in personal souls were developed by societies, they have been tenaciously retained. When, millennia ago, these traits were first evolved, their presence must have indicated greater complexity than their absence, but they are now so nearly universal that they no longer serve to distinguish between different levels of culture. Accordingly, such traits should also be excluded from the list.

Lastly, we may mention traits, such as cremation and patrilocal residence, which occur so sporadically among societies ranging widely in culture level that they too cannot be expected to distinguish consistently between simpler and more complex societies. Traits like these would be unlikely to show a significant degree of scaling and should therefore be screened out beforehand.

MORE SCALABLE SUB-SETS

So far we have spoken as if the application of scale analysis were to be only to an inventory of traits from all aspects of culture taken together. To the extent that our objective is to trace the course of cultural evolution as a whole we would indeed want to work with a single body of traits representing all fields of culture. However since functional prerequisiteness underlies scale analysis, it is reasonable to suppose that scaling would be more pronounced among a set of traits having especially close functional relationships than it would be among traits representing the whole range of cultural phenomena. In other words, within distinct spheres of culture, like political organization or religion or architecture, one would expect to find a higher degree of scaling than among traits of these and other categories of culture combined. In the terminology of scale analysis, the more homogeneous and closely related the items we work with, the likelier it is that we will find more scalable sub-sets. Needless to say, the application of scale analysis to restricted segments of culture is not only valid, but also especially promising.

DEVIATIONS FROM THE STAIR-STEP PATTERN AND THEIR INTERPRETATION

We have spoken as if we had no interest in scalogram profiles other than those which approach a perfect scale. While it is true that our goal is to reveal such profiles if they exist, a great deal can be learned along the way from scalogram patterns that deviate from it. Each aberrant + or — tells us something about the behavior of the trait it stands for. It also invites us to account for the deviation involved. There are two ways in which a scalogram may deviate from a perfect scale: plusses may appear where we expect minuses, and minuses may appear where

we expect plusses. Each of these two types of deviation is to be interpreted in different ways.

THE INTERPRETATION OF DEVIANT PLUSSES

If in the vertical column in a scalogram representing a society's inventory of traits a plus occurs well above all the other plusses in the column this tells us that a trait of relatively high rank order is present in a society of relatively low rank order. The most likely explanation for such an occurrence is diffusion of the trait in question from another society of higher cultural level. Traits which a society has obtained through diffusion would in fact consistently tend to stand above those that had been indigenously evolved. The reason for this is that from an evolutionary point of view what diffusion does is to transmit to societies traits which they have not yet been able to develop for themselves. Since many diffused traits would thus identify themselves on the scalogram, we no longer need to lament—or object—that the process of diffusion forever prevents us from unraveling the course of evolution of particular societies.

There is, however, a distinct limitation on the kinds of traits that may appear in a society's column entirely as a result of diffusion. Furthermore, this limitation does reduce the ease with which we can distinguish between traits acquired through diffusion and those developed independently. To begin with, many traits, especially those relating to social organization, do not readily diffuse.[15] Secondly, even if it is possible for a trait to diffuse, mere exposure to it may be insufficient to bring about its adoption. There are many cultural elements that can be borrowed only by a society which has attained a sufficiently high level of complexity to be able to accommodate and integrate them. A simple society may be perfectly familiar with pyramids, priests, and agricultural terraces without having any possibility of making them part of its culture. Reduced to the terms of scale analysis, this condition means that the adoption of traits by a society through the mechanism of diffusion is ordinarily limited to those traits which stand not too far above the ones that the society itself has already developed.

THE INTERPRETATION OF DEVIANT MINUSES

The second type of discrepancy that may appear in a scalogram is the occurrence of one or more minuses in an otherwise solid column of plusses. Gaps of this sort indicate the absence of a trait in a society in which we would expect it to be present. Such an absence occurs for either one of two reasons: the skipping of traits, or their supersedence.

15 Murdock, 1949, pp. 191-201.

Skipping. Societies may sometimes fail to develop traits which their total cultural inventory would lead us to expect them to have. The principal reason for such skipping is probably to be sought in environmental limitations which operate to prevent the invention of certain kinds of traits. To cite just two examples, the general absence of pottery and loom weaving among the moderately advanced societies of Polynesia may well have been due to the lack of suitable clay and of textile fibers on those islands.

It should be noted that the effect on culture of unusual environmental conditions is ordinarily negative rather than positive. That is to say, peculiarities of habitat will ordinarily lead to unexpected absences of traits rather than to unexpected presences.

Supersedence. A gap may also appear in a society's column of plusses, not because the society never developed the missing trait but because, having once developed it, the society later lost it. If a trait were to be superseded from among any considerable number of societies in our sample, we would ordinarily eliminate it summarily from our list of scalable items. But if the absences of such a trait manifested some kind of pattern on the scalogram we would do well to attempt to discover what regularity might lie behind its disappearance. The following hypothetical example will serve to suggest the subtle and interesting relationships that might be involved.

	A	B	C	D	E	F	G	H	I	J	K	L	M
10	−	−	−	−	−	−	−	−	−	−	+	+	+
9	−	−	−	−	−	−	−	−	−	+	+	+	+
8	−	−	−	−	−	−	−	−	+	+	+	+	+
7	−	−	−	−	−	−	−	+	+	+	+	+	+
6	−	−	−	−	−	−	+	+	+	+	+	+	+
5	−	−	−	−	−	+	+	+	+	+	+	+	+
4	−	−	−	−	+	+	+	−	−	−	−	−	−
3	−	−	−	+	+	+	+	+	+	+	+	+	+
2	−	−	+	+	+	+	+	+	+	+	+	+	+
1	−	+	+	+	+	+	+	+	+	+	+	+	+

FIG. 5. Scalogram showing perfect scaling except for the absence of Trait 4 among Societies H through M.

The scalogram in Fig. 5 constitutes a perfect scale except for the fact that a line of minuses appears at the right-hand end of the row along which are shown the presences and absences of Trait 4. Let us assume that these minuses indicate

the absence of *clans* among the six societies involved. How are we to interpret these absences? First of all, we notice that clans make their initial appearance with Society E, are present among Societies E, F and G, and are absent from Societies H through M. If we then look higher on the scalogram we will see that the dropping out of clans (Trait 4) coincides with the advent of Trait 7. Now let us assume that Trait 7 is *territorialism,* that is to say, the basing of socio-political

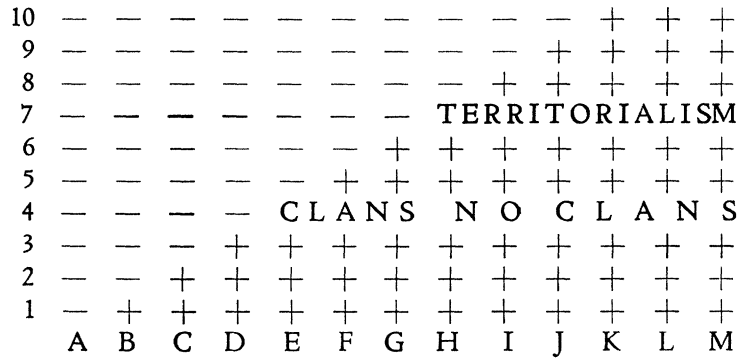

FIG. 6. Scalogram showing a hypothetical inverse relationship between the presence of clans and territorialism.

organization on territorial units rather than on the principle of kinship. The fact that these two traits appear on the scalogram (see Fig. 6) as mutually exclusive *distributionally,* strongly suggests that they are inversely related *functionally.* In other words, something about the onset of territorialism seems to lead to the elimination of clans. Thus, what at first appeared to be a puzzling aberration turns out to be an instance of a regular and orderly process of change, even if not of the cumulative type with which our study is primarily concerned.

I do not mean to imply that the supersedence of traits could always, or even usually, be explained so neatly and easily. But I do believe that by careful examination of the irregularities that may appear on scalograms we should be able to propose reasonable explanations for a considerable number of them.

SCALE ANALYSIS AND THE RATING OF CULTURES

Our discussion so far has focused on the utility of scale analysis in ordering culture traits into an evolutionary sequence. It follows that if such a sequence should turn out to exist, then the number of scale traits a society possessed could be taken as a measure of its degree of cultural development: the greater the

number of traits, the higher the level of culture. Scale analysis thus may provide us with a convenient yardstick for rating societies objectively in terms of their inventories of significant cultural elements.

The work that I have carried out so far in applying scale analysis to human societies convinces me that rating cultures by means of a list of scale traits is entirely practicable. Even the preliminary list of 358 traits that has been used so far, a list whose degree of scaling has still to be thoroughly tested, has given what to me seem good results when used to rank order societies. For example, the presence or absence of the 358 traits on this list has been recorded for four societies with the following results: [16]

Society	*Number of Traits*
Marquesans	106
Molima (New Guinea)	58
Kuikuru (Brazil)	21
BaMbuti Pygmies	3

These numerical scores not only rank the four societies in what I believe most anthropologists would agree was their correct order of complexity, but the differences in magnitude between them also appear to indicate rather well the relative degrees of difference in culture level among them.[17] Translated into evolutionary terms, these results would mean that the Marquesans have traveled along the path of cultural development further than the Molima, the Molima further than the Kuikuru, and the Kuikuru further than the BaMbuti.

SCALE ANALYSIS AND THE STUDY OF PROCESS

Contemporary students of cultural evolution appear to be particularly concerned with problems of process. It may therefore occur to some of them that scale analysis falls outside the mainstream of modern evolutionism because it does not deal directly with process as such.

It is true that scale analysis as described and employed in this paper is a technique for determining *sequence* rather than *process*. The question we ask of it is,

16 The information on the Kuikuru comes from my own field work among them. The data for the Marquesans, Molima, and BaMbuti were very kindly provided by Robert C. Suggs, Ann Chowning, and Colin M. Turnbull respectively, each a specialist in the particular culture.

17 This is not the first time that the use of a list of scalable items to rank order societies along a continuum of increasing complexity has been suggested. Indeed, this idea forms the basis for the study by Freeman and Winch (1957), and is explicitly recognized by Rose and Willoughby (1958:484).

"What has been the course of cultural development?" rather than "Why have societies evolved in the way that they have?" However, anyone should be able to appreciate the fact that if scaling is found to occur in culture, it would have the very greatest implications for the study of process. If the existence of a general evolutionary sequence can be established, all manner of questions regarding the mechanisms and dynamics lying behind such a sequence immediately arise.

Suppose we were to find, for example, that in the evolution of societies slavery, confederacies, priests, human sacrifice, markets, monarchy, courts of law and the corvée consistently followed each other in that order. The very occurrence of this sequence, once recognized, would serve as a challenge to us to apply our knowledge of process and to formulate an explanation of that regularity. I am convinced, in fact, that one of the handicaps under which students of the evolutionary process have had to labor is that many developmental regularities—the raw materials for their theories and interpretations—still lie undiscovered or unrecognized. Since scale analysis is peculiarly well suited to reveal such developmental regularities, it should turn out to be an extremely useful adjunct to the student of the evolutionary process.

CONCLUSION

In this paper I have tried to explain scale analysis and to show that it constitutes a powerful instrument for the study of cultural evolution. By means of scale analysis we should be able to probe more deeply than ever before into the developmental regularities that have characterized the history of human societies. The next step is to apply it.

Needless to say, to do so on a broad scale and in a thorough-going manner will require years of the most tedious kind of work, as well as the collaboration of many interested persons. But the outlook is promising, the goal is worthwhile, and the tools are at hand.

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