

or to subtract the resting metabolism from the total and consider the remainder as the energy used in running, or, as I have done here, subtract value for the Y-intercept. The procedure must depend on the purpose we have in mind. I have discussed the net cost of locomotion—that is, the cost of locomotion per se. The total energy expenditure during locomotion is higher, but equally correct. For example, a migrating bird uses its fat reserves for flying, and the distance it can cover on the available fuel is determined by its total metabolic rate. Likewise, a grazing sheep must obtain enough food to cover, not only the energy cost of walking, but enough for its total metabolic needs. Therefore, there is no reason for controversy, so long as we have defined the terms in estimating the cost of locomotion.

38. A comparison with man-made machines shows that automobiles use about twice as much energy in locomotion, per unit weight, as a horse (about $0.5 \text{ cal g}^{-1} \text{ km}^{-1}$). Big jet airplanes use about the same amount of energy as a horse per unit weight, but smaller planes use progressively more energy, and helicopters use nearly ten times as much as a horse. Ships use less energy, however, and an economical long distance freighter may, per unit weight, use almost as little as one-tenth the energy used in locomotion of a horse.
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The Evolutionary Taxonomy of Culture

A few behavioral factors account for the regional variation and evolutionary development of culture.

Alan Lomax with Norman Berkowitz

The grand theme of anthropology is that man, to a far greater degree than the other animals, adapts to his environment by means of changes in socially transmitted, rather than biologically inherited, patterns of action and interaction. The ways of a people—its economic, affective, political, communicative, and expressive systems—are learned and may be changed by each succeeding generation. Margaret Mead tells how the Manus, a Stone Age people, were so impressed by Western culture that they decided to get rid of their own and straightway threw much of it into the sea (1). This instance illustrates the malleability of culture. It is this flexibility of cultural, as compared to biological, systems that gave man an advantage over other species and enabled him, early in his history, to occupy every zone of the globe.

Since cultures consist of enormous complexes of customs, beliefs, institutions, and modes of communication, they could only be transmitted, before the invention of written language, by whole societies. An ideal cultural taxonomy should, therefore, discover a series of geographically continuous culture regions, each explicable as a pattern of adaptation that was carried from its zone of origin to others along feasible land or sea routes. The borders of a given culture region should be defined by physical barriers or by the limits of other such culture regions. Any breaks in the distribution of such a culture continuum should be explained by the intrusion of another, more productive and better adapted cultural system. It should be possible to arrange these geographically bounded cultural taxa in a developmental sequence that would account for their boundaries and their discontinuities. Thus, human subspeciation could be viewed as a continuum of cultural adaptations with several regional specializations.

The factored cultural taxonomy presented here meets those requirements.

Its weak spots occur exactly in those places where it lacks data, which may, with further effort, be supplied. Otherwise, its inclusiveness and its parsimony recommend it. First, the scheme accounts for most of the variation in human cultures by a small number of discrete cultural zones (Fig. 1) organized into three large regional clusters (Fig. 2): (i) the simple producers; (ii) the tropical gardeners; and (iii) the Eurasian agriculturalists. Each of these regions represents a decisive adaptive development. Second, factor analysis clusters the measures of culture themselves around two main vectors: (i) economic and social control of the environment, and (ii) organization and integration of teams. Vector 1 orders the main zones of culture on a steadily rising curve of socioeconomic development. Vector 2 (which depicts the form of team organization each subsistence level requires) oscillates in a regular, wavelike fashion along the curve of progress as the species deploys, again and again, its limited repertory of organizational resources (Fig. 5). A third group of factors, which includes the organization of kin and family, shows no clear vectored relation to evolutionary development.

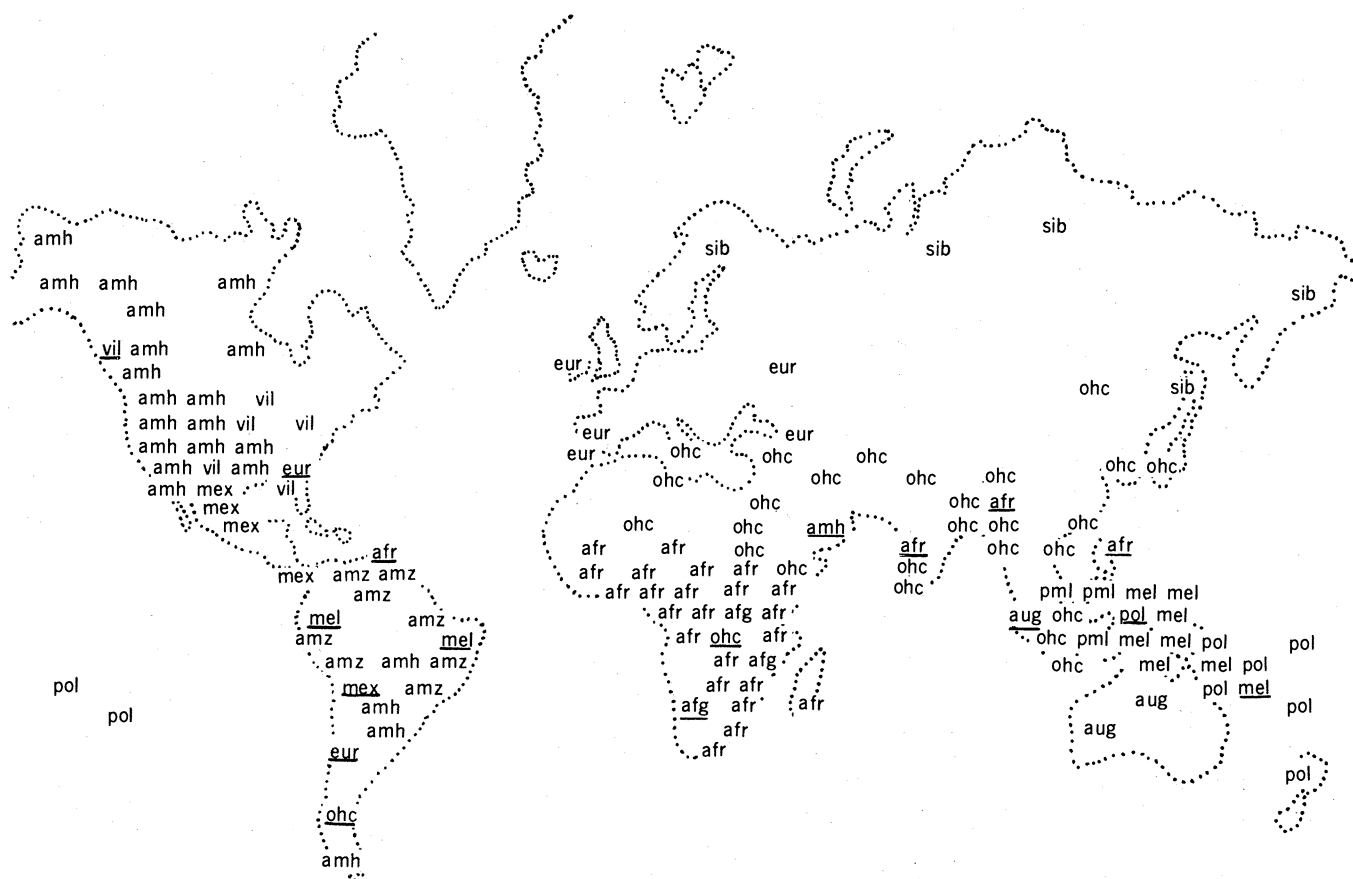
The data for this evolutionary taxonomy came from two sources—a comparative survey of world song styles and a similar survey of ethnography: namely, G. P. Murdock's *Ethnographic Atlas* (2). Murdock encodes from the literature of ethnology the economic, social, and political features of more than 1000 societies. In some cases, these codes formed scales—for example, the one concerning the number of levels of political authority outside the local community, from 0 among hunters to 4 for Oriental empires. In other cases, Conrad Arensberg and I arranged the codes into scales in order to measure the relative frequency of certain kinds of behaviors or features of culture, such as level of

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The data relating to the variance of human communication systems came from a somewhat novel source—a worldwide study of song performance style. Earlier areal classifications of cultures had incorporated linguistic identifications, but with minor taxonomic effect. There are two reasons for this. First, languages can be learned as systems and, as such, can move easily across cultural borders. Second, languages, as they have so far been described, seem not to vary in any regular

The Cantometric study of song (3), however, revealed strong statistical relations between song style and social norms—for instance, that the explicitness, or information load, of song varies with the level of economic productivity, that cohesiveness of performance is an indicator of the level of community solidarity, that multipart singing occurs in societies where the sexes have a complementary relationship, and that degree of ornamentation increases with increased social stratification (3). Thus song appears to function as a reinforcement of a culture's social structure, and profiles of song performance can be used as indicators of culture pattern. Since the Cantometric measures report on how people use their voices or organize their choruses, they point to patterns of behavior transmitted as part of

These conclusions are based on the analysis and comparison of 4000 recorded song performances from about 400 different cultures, located in every world zone. It was this first panhuman study of communication that produced scaled data on norms of group organization and models of communication to match the species-wide scoring of socioeconomic patterns in the *Ethnographic Atlas*. The descriptive grid combining these two sets of measures was sizable and so was the number of societies required to represent the whole range of human culture. Norman Berkowitz devised a special adaptation of the varimax rotation multifactor analysis to classify these complex profiles. This computer procedure swiftly compares a large number of cultures on a long roster of scales, clusters the most similar cultures, and then picks out the distinctive profiles of each cluster. It has two different outputs—Q, factoring of



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cultures, and R, factoring of scales of culture measurement. The criteria I established to estimate the success of these operations are postulates of some importance to the comparative study of human behavior.

Taxonomic Criteria

The members of each of the culture factors should outline one continuous geographic zone through which a cultural pattern or style might have migrated or been transmitted from group to group. Any discontinuous geographic factor must have a clear historical explanation—for instance, the shattering of one cultural continuum by another, invading tradition. The “best” of several geographic factor runs is the one that

satisfies these criteria, which together define the culture hypothesis—that most human behavior is determined by complex patterns of learned behavior transmitted through the centuries in the same territory.

The criterion for the success of the factoring of measures is that each cluster of measures should be conceptually pure—that is, capable of being given a label that characterizes all of its members. All members of such a factor can then be viewed as formalized manifestations of the same deep attribute or general characteristic of culture. It is here assumed that the principle of substitutability is applicable to culture as well as to communication: just as a series of gestures or statements can serve as interchangeable symbols for a thing or an idea, so a set of behavioral norms can

interchangeably represent the same underlying cultural attribute. Thus one may account for the endless amplifications of human behavior in terms of the regrouping of a small number of deep attributes.

These two criteria—one for geographic continuity and the other for operational unity—were used to test the acceptability of the factor analyses. When a culture factor that was run through the computer did not meet the geographic criterion, we usually found that our sample was defective. For example, if too many neighbors of a given culture were missing, it might be grouped with similar, but inappropriately distant, cultures or remain unclassified. When a measure was inappropriately grouped, this usually pointed to defects in its structure, which might then be remedied. The input of culture profiles and measures was changed in run after run until both criteria were approximately satisfied. The simplicity of these tests and the flexibility of the computer procedure itself provide an excellent method for the objective comparison of the multimember, multifaceted phenomena called cultures.

The Geographic Taxa

In order to provide a balanced picture of the range of human culture, I used a subset of the Murdock standard test sample of culture, in which geographic neighbors and duplicates have presumably been eliminated. The subsample, for which there were data on both song performance and social structure, include 148 cultures from the 186 provinces in the Murdock sample. In the Q, or geographic phase of the factoring, the computer grouped over 90 percent of this sample into 13 clusters, or factors, which were either geographic or historical continuums, or both. Each of the 13 has a clear-cut and distinctive profile of traits (ten profiles are partially presented in Fig. 3). In other words, each of these 13 cultural factors can be viewed as a distinct subvariety or style of human culture, a historical-geographic continuum of one pattern of adaptation. The map in Fig. 1 presents the geography of these 13 culture styles; the distribution of each one can be traced by its abbreviation. Brief descriptions of these 13 cultural factors follow.

1) Siberia: A continuous zone of nomadic hunters, fishers, and reindeer herders, from European Lapland across

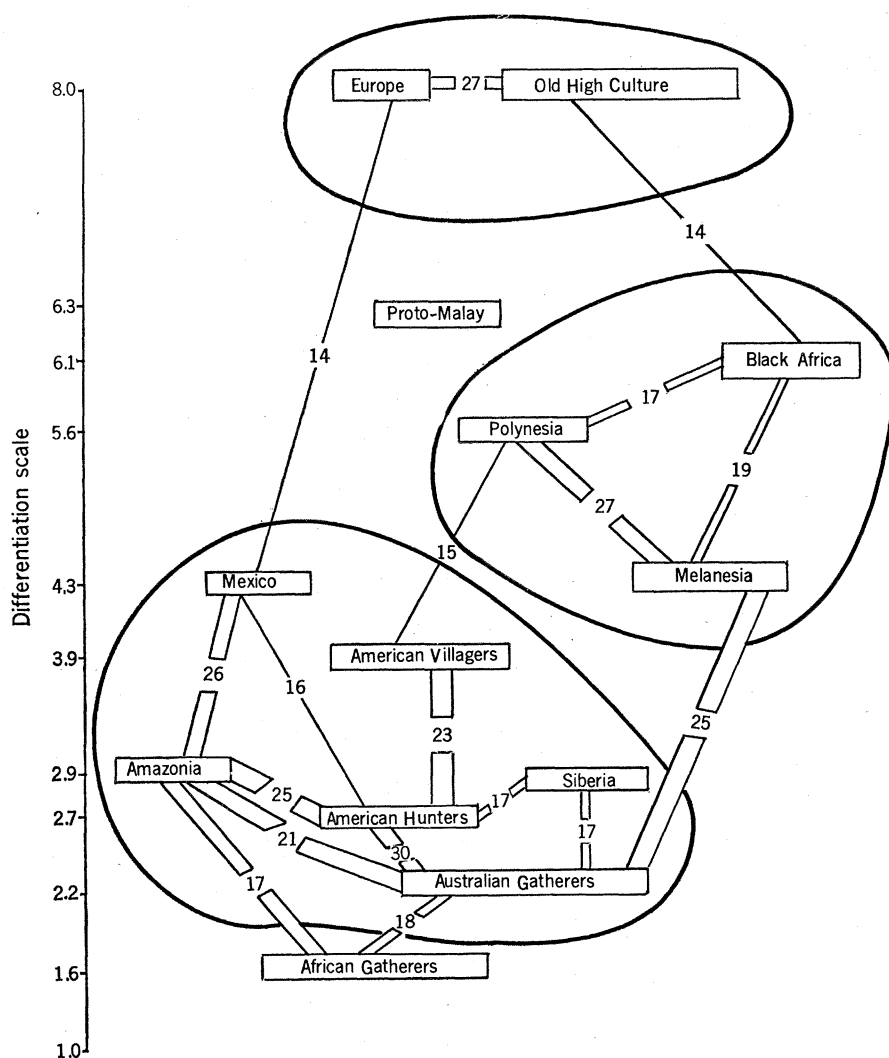


Fig. 2. Numerical scores for each of the 13 main geographic factors were calculated on the differentiation factor. The vertical axis shows the resultant scale, with a point for each of the 13 main geographic factors. Connections between the boxes represent the residual bonds, or levels of similarity, between the geographic taxa. Each of the taxa is limited to its two highest bonds. The differential strength of the bonds is indicated by the width of the connecting lines. No bond lower than the mean of 13 for the whole field was allowed.

Siberia to Kanchatka. Two paleo-Siberian cultures, the Yukaghir and the Ainu, are equal members of this and the Amerindian Hunters zone, thus indicating a common origin in early Siberia for both of these clusters.

2) Amerindian Hunters: A clustering of the hunters and fishers of the American Arctic and the Northern Plains with those of Mato Grosso, the

Gran Chaco, and Patagonia. This clustering points to the existence of a continuous distribution of an ancient cultural substratum across both continents—a continuum broken by the rise of agricultural adaptations, represented by the following three clusters.

3) American Villagers: Corn farmers of the Eastern woodlands and prairie areas and the pueblo-dwelling, dry-

wash irrigationists of the Southwest. These cultures would probably have formed an unbroken continuum if information from the Mississippi Valley cultures, such as the Natchez, had been available.

4) Amazonia: The forest-dwelling, seminomadic, root gardeners and riverine fishers of the Amazon and Orinoco basins.

	1 African Gatherers (1.6)	2 Australian Gatherers (2.2)	3 American Hunters (2.7)	4 Amazonia (2.9)	5 American Villagers (3.9)	6 Melanesia (4.3)	7 Polynesia (5.6)	8 Black Africa (6.1)	9 Europe (8.0)	10 Old High Culture (8.0)
Differentiation	Succession of leader	Absent	Hereditary						Formal	
	Milking	None							Present	
	High gods	None	None	None	Otiose			Otiose	Involved	
	Games	PS & C	None	Physical skill and chance				Strategy		
	Metal	None						Present		
	Stratification *	None					2	3 to 4		5 to 7
	Land inheritance	None					Present			
	Size of animals	None				Pigs		Cattle, sheep and goats		
	Animal husbandry	None				10 to 20%		30 to 40%		
	Permanence of settlement	Bands		Seminomadic		Villages or nuclear				
	Extra-local government*	None			2	None	2	1	3	
	Size of settlement	Fewer than 49			200 to 400				50,000	5 to 50,000
	Roots versus grains	None		Roots	Grains	Roots		Grains		
	Intensity of agriculture	None		Extensive		Horticulture		Extensive	Intensive	Irrigation
	Production scale	Extracting		Incipient		Gardening			Plow	Irrigation
Communication	Fishing	10%	20 to 30%	40% plus	20 to 30%		40% plus		10%	
	Collecting/game	Collecting		Game	Less than 10% of either					
	Embellishment	Little		Little	Some	Little				Much
	Leader/Group	Group	L/G		L/G	G/L	L/G	Group	Solo	
	Variation	Little		Little		Little		Much		Much
Integration	Interval size	Wide	Narrow	Wide		Mid			Mid	Narrow
	Enunciation	Slurred			Mid	Slurred	Precise	Slurred	Precise	
	Wordy/Nonsense	Nonsense		Nonsense / wordy		Nonsense	Wordy/nons	Mid	Wordy	
	Division of labor †	Female		Male	Female				Male	
	Solidarity index	Nonsolidary			Solidary				Nonsolidary	
	Community organization	None	Clan	None	Clan		Ramage	Clan	None	
	Tonal blend	Good	Medium	Poor	Good		Good			Med-poor
	Vocal organization	Integrated	Diffuse	Unison		Integrated				Solo
	Vocal width	Very wide	Narrow	Mid	Wide					Narrow
	Rasp	Little	Great			Little		Great	Mid	Great

Fig. 3. The emergent traits of the differential control factor. All entries correspond to scale steps used in the factor analysis; no entry is made in any location unless it is statistically distinctive and different from the entry in the column to its left. For example, the distinctive scores for the first stage, African Gatherers, are largely zeros in the societal rows, whereas the scores for group organization and performance point to high levels of performance integration. The zero scores of the Australian Gatherers in most of the same columns are indicated by their inclusion in the same bars. Exceptions point to hereditary clan leaders and a tense-voiced, diffuse performance style. In the same way, all entries in any succeeding stage record only significant changes from the previous stage—that is, changes that are statistically distinctive and thus can be considered truly emergent. Blanks occur where no clear and distinctive trait was found in a column or culture zone. Dashed lines serve only to make the diagram easier to read. Numbers in parentheses under each of the column heads indicate their numerical standing on the differentiative factor. (* Number of levels. † The sex contributing more than 50 percent to the main productive task.)

5) Nuclear America: A somewhat flawed continuum (reaching from northern Mexico through middle America to Peru) of societies affected by the development of Amerindian civilizations.

6) Australian Gatherers: A cultural continuum on the subcontinent of Australia prior to the arrival of Europeans in the 18th century.

7) African Gatherers: Bushman and Pygmy groups occupied most of Africa south of the Sahara, before the coming of black herders and gardeners in the last two or three millennia.

8) Black Africa: A continuous distribution in Africa showing the spread of gardeners and herders through the southern half of the continent and, recently, into the Americas. Inclusion of tribal Indian culture in this cluster suggests that an old transoceanic continuum of tropical agriculture once connected Africa with lands to the east.

9) Melanesia: Includes the horticulturalists and pig farmers of New Guinea, Melanesia, and nearby Micronesia, along with two similar South American societies, the Timbira and the Bora Witoto.

10) Polynesia-Pacific: The seafaring cultures of the Pacific, including the Motu of southern New Guinea, the eastern Micronesians, and the Polynesians.

11) Proto-Malay: In spite of a weak sample, this factor outlines the spread of rice-growing Malay people (the so-called "bamboo culture") from the hills of Indochina to Borneo and the Philippines.

12) Old High Culture: Shows the spread of cities, empire, irrigation, and craft specialization from the Middle East, west through the Mediterranean, south with the Cushites into central Africa, and all the way east through India, Southeast Asia, and Indonesia into east and central Asia.

13) Europe: The hard-grain, plough, dairying agriculturalists of Europe and colonial America.

Four of the 148 cultures remained unattached and unique—the Miao Tibeto-Burmans, the Andean Aymara, the Zadruga Strpci of Yugoslavia, and the cattle-herding Mesakin of Kordofan. Five cultures were classified out of region: the Bedouin in factor 2, the Araucanians in factor 12, the Timbira and Bora in factor 9, and the Sajek of Formosa in factor 8. Thus, only 7 percent of the sample of 148 cultures remained outside of this system of regional cultural continuums. Otherwise, the classification fulfills the first of the two taxonomic criteria surprisingly well, con-

sidering the state of available data. A set of homogeneous and continuous regions of culture, each with a distinctive behavioral and adaptive profile, presents a coherent picture of human subspeciation.

The Behavioral Taxa

A number of other anthropologists have applied factor analysis to culture, most of them using the criteria in the *Ethnographic Atlas*. Their findings (4) point in a similar direction to those presented here.

Multifactor analysis of our 71 measures of social and communicative structure clustered them into 14 factors and five single measures. Inspection of the display of these factors (see box) shows that most of them are conceptually pure and clearly represent some single tendency or deep attribute of culture. The four apparent exceptions to this rule all imply interesting hypotheses, which may produce further unities.

Factor 13, in which the availability of milk products is linked to vocal dynamics, suggests that this extra source of protein accounts for many cases of energetic vocalizing. In fact, loud and forceful singing does seem to be more common where protein is plentiful.

Factor 6, which clusters the measures of sexual sanctions with vocal noise, relates to a finding, fully established in earlier research (3, pp. 194–195), that degree of voice tension varies directly with the severity of sexual mores. Factor 3 properly includes collecting versus hunting with sexual division of labor, since gathering is largely a female, and hunting largely a male, activity.

The composition of factor 2 suggests a number of interesting ideas. First, games of strategy, like checkers, grow popular after the management of herds of milk-producing animals becomes a central cultural theme. Second, the incorporation in the produce factor (factor 2) of the scale dealing with beliefs about the presence and potency of high gods is fascinating. Swanson's pioneer work (5) indicated that the development of religious belief, from animism, through polytheism, to monotheism, paralleled the rise and centralization of political authority, from the acephalous tribal council, through the feudal confederacies, to centralized monarchy. The connection of monotheism to milking, implied in the structure of factor 2, suggests, moreover, that the spiritual authority of powerful divinities repre-

sents the control of the triad of essential foods—namely, grain plus meat and milk—on which the members of specialized agricultural and pastoral societies came increasingly to depend. In fact, belief in one, authoritarian, male god does seem to have originated in the patriarchal cultures of the Middle East, where control of the herds and land rested in the hands of the male head of the patriline.

It thus appears that the 71 measures, which reduced the variety of human culture to a small number of homogeneous culture regions, represent no more than 19 attributes. If the geographic taxonomy of culture presented earlier (Fig. 1) is judged to be fairly satisfactory, then a compact set of terms such as these 19 may be sufficient to describe and classify human culture and, insofar as behavior is cultural, human behavior itself. Actually I shall try to show that a successful taxonomy of culture and an acceptable account of cultural evolution can be achieved with only 5 of the 19 factors. Moreover, these five may be lumped into two vectors, the interplay of which has shaped the development of culture and the emergence of the subspecies of man.

A Tree of Culture

Factor 1 puts the scales of economic productivity, increase of population, stability of settlements, and centralization of political and social controls together with measures of the amount of information the performance carries, as indicated by the importance of small intervals, precise enunciation, and non-repeated text. It has been established elsewhere that the explicitness, or information load, in song performance increases directly with the productivity of the subsistence system and with other features of the social economy (3). Indeed, there appears to be a lawful relation between the explicitness of communication performance and increased productivity and political centralization. Therefore, postponing further discussion of the relations among these variables (Fig. 3), I shall consider that all of these measures together represent the effect of one powerful cultural attribute—man's concern with differential control of his environment. Change here affects the whole social, economic, and communicative structure. In a word, human culture evolves as its differentiative capacity increases.

The tree diagram (Fig. 2) offers a

cursory view of this evolutionary principle. Here the 13 culture zones presented earlier are arranged on a vertical scale of increasing differentiation. The numbers along the vertical axis are calculations of the weighted average of the 13 on the differentiation factor. The scale rises from 1 and 2 for Australian and African gatherers to 8+ for agriculturalists of Europe and Asia. The effect of industry was not considered here because reliable ratings of industrialized cultures were not available.

The branches of this evolutionary tree are formed by the residual bonds of similarity that link the 13 culture types. These linking bonds were also derived by the computer, which, once it had established independent geographic factors, then calculated the residual similarity between these cultural taxa. The two highest bonds for each of the 13 are drawn between them to complete the tree diagram and to show how the taxa are interrelated along its branches. Note, for instance, that Melanesia is linked by its highest bonds to its closest

geographic and historical congeners—to Australia by .25 similarity and to Polynesia-Micronesia by .27 similarity. Interlinking establishes interesting families, such as a circum-Pacific region of simple producers. Black Africa's highest bonds tie it to Polynesia and Melanesia, shaping a world family of tropical gardeners. However, the ancient cultural link of Black Africa to the Middle East shows up in the bond of 14 between the Old High Culture and the African factor.

Indeed, this purely numerical opera-

A summary of the factor analysis that grouped the 71 measures of social and performance norms into 14 clusters and 5 single factors. Each cluster consists of two or more measures. With a few exceptions, all measures in these clusters represent a single deep attribute of culture. Indented measures are either attached with equal strength to two factors or also occurred as a unique or single factor.

- | | | |
|--|--|--|
| <p>1) <i>Differentiation</i>
 Productive range
 Intensity of agriculture
 Percent of animal husbandry
 Size of settlement
 Number of extra-local hierarchies
 Inheritance of land
 Degree of stratification
 Presence of metalworking
 Task differentiation by sex
 Percent of repeated text
 Percent of precise enunciation
 Interval size
 Degree of melodic variation
 Severity of premarital sex sanctions
 Games of skill versus games of strategy
 Rules for leadership succession (unique)
 Difficulty of wiving (unique)</p> | <p>4) <i>Organization of groups</i>
 Importance of leaders versus group
 Unison versus multipart choruses</p> <p>5) <i>Level of cohesiveness</i>
 In rhythm of vocal group
 In vocal blend
 In orchestral tonal blend
 In rhythm of orchestra
 Organization of vocal group rhythm orchestral rhythmic type</p> <p>6) <i>Noise and tension</i>
 Raspy vocalizing
 Nasal vocalizing
 Tight and narrow vocalizing
 Severity of premarital sex sanctions</p> <p>7) <i>Ornamentation</i>
 Melisma
 Glissando
 Embellishment
 Glottal shake
 Tremolo
 Degree of melodic variation</p> <p>8) <i>Community type</i>
 Solidarity-index
 Unilineal-bilateral
 Solidary kin organizations
 Kinship system</p> <p>9) <i>Matri-patri</i>
 Female-male inheritance of real property
 Female-male inheritance of movable property
 Marital residence rules (F-M)
 Matrilineal-patrilineal</p> | <p>10) <i>Size and type of statement</i>
 Number of phrases
 Litany, strophe, through-composed
 Symmetry of form
 Melodic range
 Presence and activity of gods</p> <p>11) <i>Orchestral model</i>
 Social organization of the orchestra
 Unison versus multipart in the orchestra
 Organization of orchestral group rhythm
 Relations of orchestra to vocal part orchestral rhythmic type</p> <p>12) <i>Vocal rhythm</i>
 Vocal rhythmic type (regular to irregular)
 Tempo
 Phrase length</p> <p>13) <i>Dynamics</i>
 Soft-loud vocalizing
 Lax-forceful vocal accents
 Low-high register
 Importance of milking</p> <p>14) <i>Part organization</i>
 Type of polyphony
 Social organization of chorus</p> <p>15) <i>Type of family</i></p> <p>16) <i>Size of family</i></p> <p>17) <i>Segregation of boys</i></p> <p>18) <i>Female dominance in pottery, weaving, leather-work</i></p> <p>19) <i>Position of final note in songs</i></p> |
| <p>2) <i>Caloric value of produce</i>
 Size of domestic animals
 Root versus grain agriculture
 Percent of fishing
 Importance of milking
 Presence and activity of gods
 Games of skill versus games of strategy
 Kinship system</p> <p>3) <i>Sexual division of labor</i>
 In main productive activity
 In overall productive acts
 Percent collecting versus percent hunting, fishing</p> | | |

tion arranges human cultural families in a highly provocative way. The known historical relationships among the 13 areas are reaffirmed, with the one exception of Malaysia, where the sample is weak. The diagram points to the ongoing tie between European and classical Oriental civilization, Polynesia and Melanesia, primitive America and its Siberian roots, and to the separate branching out of Indian cultures in the Americas. The intercontinental affiliations of the African and Australian gatherers suggest that these two clusters represent the earliest and most generally distributed culture types of which we have a living record. Although hunting is practiced by both, it is clearly a secondary, although valued, source of food. These facts suggest that gathering, rather than hunting, was the first major subsistence activity of human beings. This finding, if true, overturns the now popular view of early man as a blood-thirsty caveman, whose adaptive success was due to his interest in weaponry combined with a calculated ferocity. Like our nearest relatives, the great apes, and like present-day gatherers, early human societies were probably nonaggressive, highly intrasupportive teams of foraging amateur botanists, quarterbacked by women and guarded by males.

Beyond the gatherers, three grand regions of culture, ringed by circles in the diagram, can be seen in the clusters of interbonded factors. Two of the regions are known—the Eurasian and the circum-Pacific. The latter embraces all of the primitive producers of the Pacific rim, from Australia, through Melanesia and Siberia, and into Amerindia. The clear emergence of an Afro-Oceanic region supports the hypothesis that a continuous ring of gardening cultures once linked Oceania to Africa in the tropical latitudes. Only traces of this ancient human distribution seem to have survived the incursion of higher cultures in Malaysia, Indonesia, and Southeast Asia. However, in main features of social interaction, and especially in song and dance style, the peoples of Black Africa and the maritime Pacific affirm an ancient cultural allegiance. Their shared patterns include a complementary relation between the sexes; emphasis upon fertility as a central social value; and social solidarity manifested in massed choirs of rhythmically unified performers and workers, in sensual hip-swinging, polyrhythmic dancing, in polyrhythmic orchestras, and in open-throated, polyvoiced choruses. All these habits are

highly functional in a solidary, village, gardening economy without a complex technology.

The computer weighed a mountain of evidence to produce the numbers that point to the existence of this tropical factor. If this arrangement of cultures proves acceptable, one can take very seriously the following grand scheme of human cultural evolution.

Stage 1, African Gatherers: Less than 2 for differentiation score, low productivity, nomadic bands, acephalous, egalitarian, complementary social relationships, cohesive and highly integrated singing organization, and polyrhythmic, flowing, sensuous dance style. These are found among the Bushmen and Pygmies of Africa, with traces in refuge areas on every continent.

Stage 2, Circum-Pacific simple producers: About 3 for differentiation score, seminomadic, basically acephalous, males dominate productive and social relations, hunting, fishing, or slash-burn agriculture without animal husbandry, individualized and unison singing organization, and a linear dance style. This culture type presumably spread from a hunting origin in Siberia, around the perimeter of the Pacific, and flowered in the Americas.

Stage 3, Tropical gardeners: About 5.5 for differentiation score, full agriculture with animal husbandry, settled villages, confederacies, a two-class system, complementary productive and social relationships, great solidarity in community life, cohesive and polyvoiced singing, and highly erotic, synchronous, and polyrhythmic dance style. An early continuous distribution is indicated—from Melanesia, through Southeast and southern Asia to East Africa and the Sudan, later spreading into sub-Saharan Africa, east into Polynesia, and west into the New World.

Stage 4, Eurasian plow agriculture: 8 for differentiation score, large towns, centralized government, complex stratification, male dominance of productive and social system, and emphasis on virtuosic soloists in performance, with elaborate and drilled participation of chorus and orchestra.

The advantage of such an overview is not only that it sums up much of the evidence of comparative ethnology, but it also permits one to see the main events in cultural history in terms of the growth and encounter of a small number of traditions. Though not isolated, the three main traditions clearly developed in different zones of the world around distinctive adaptive and com-

municative patterns. Each gave rise to sets of regional and areal subtraditions, all of whose members share some of the distinctive traits of one parental stem, most markedly in their expressive behavior.

All of this argues for the direct relation of cultural evolution to the regional development of differentiative capacity. Figure 3 summarizes the stepwise emergence of the differentiative components through time. The evolutionary scale of culture types is used as the horizontal axis, from African Gatherers on the left to Old High Culture on the right. The entries in the column above each evolutionary stage are those, and only those, traits that became statistically distinctive at that level.

Column 1: Among the acephalous, nomadic, freely associating African Gatherers, most familiar traits of social control are absent, just as their performances are empty of explicit and group-controlling content.

Column 2: Emergent traits for Australian aboriginal societies outline a masculine gerontocracy, in which elder male clan heads control the sexual, economic, and ritual life of their people. Note an accompanying rise of narrow intervals and of voice tension indicators, as well as an accompanying drop in performance cohesiveness.

Column 3: Men become the principal producers in the diffusely bonded hunting-fishing economies of America and Siberia, and this masculine productive dominance is symbolized by the importance of male solo performances and male choruses singing in rough unison.

Column 4: In the Amazon-Orinoco Basin, loosely bonded, bisexual teams carry out a rudimentary agriculture, and song performances are notable for diffuseness and multipartedness.

Column 5: Among aboriginal North Americans, corn farming fosters larger communities, tribal confederacies, and clan-based community organizations whose solidarity and complementarity are reflected in the unity and frequent bisexuality of singing and dancing groups.

Columns 6, 7, and 8: In Melanesia, Polynesia, and Black Africa, the need for highly synchronous male-female work teams to carry out the monotonous routines of year-round agriculture emerges in the usually cohesive, multipart, male-female dancing choruses of the tropical gardeners. Here the extra nourishment resources of horticulture and animal husbandry give rise to stable settlements, systems of land in-

heritance, and social stratification. In Black Africa, sheep, goat, and cattle culture, grains, and metallurgy give rise to further social stratification, kingdoms and empires, and a passion for games of strategy resembling chess.

Column 9: In Europe, intensive plow agriculture, and an increase in animal husbandry and dairy products stimulates the growth of cities, where centralized governments replace local, kin-based organizations in authority. An authoritarian monotheism arises, males take over the main roles in the productive system, and highly explicit song style becomes the rule.

Column 10: The centralization of economic and political control, essential in large riverine irrigation systems, leads to further centralization and stratification in much of the Orient. The musical specialist appears, addressing the center with long, complex, highly embellished songs, loaded with the tension of an alienating and authoritarian social system.

These seem to be the main stepwise developments in the evolution of cultures as outlined in the present factor analysis. A steady buildup in subsistence productivity is at first accompanied by changes in male-female division of labor and in lineage organization, and then (from the middle of the scale on) by mounting stratification and political centralization. Ever more highly articulated societal entities are mirrored in more and more explicit performance style (3, pp. 194-199). All of these developments contribute to a steadily rising curve of differentiation. Some important aspects of social and performance organization, however, do not conform to this curve of progress. Figure 3 shows that women dominate in gathering and gardening subsistence systems, while males dominate in hunting and intensive agriculture, and that cohesive, noise-free, highly integrated, rather than leader-dominated, performance peaks among African Gatherers and among gardeners. This contrast confirms the finding that a highly integrated style of performance is typical of complementary and solidary communities, whereas noisy, tense-voiced, solo, unison, or diffuse performance occurs in male-dominated, loosely bonded, network-like societies (3, pp. 130-148). It seems, therefore, that the prevalent performance style of a culture reflects and reinforces not only the degree of differentiative control, but the degree and kind of group integration that is appropriate and necessary to the culture's adaptive structure. There is, in

other words, a parallel between the way cultures synchronize activity in productive efforts and in expressive performances.

Supporting evidence for this hypothesis comes from S. H. Udy's cross-cultural study (6) of how work is organized. I have extracted from Udy's study pertinent data on the structure of tasks and teams in a hundred cultures, from gatherers to irrigators. The percentage of stable work teams by region is as follows: African Gatherers, no score; Australian Gatherers, 33; American Hunters, 20; Amazonians, 0; American Villagers, 95; Melanesia, no score; Polynesia, 91; Black Africa, 85; Europe, 25; Old High Culture, 44.

It appears that stable teams occur most frequently where choral solidarity is highest—among the gardeners. The personnel of hunting and fishing parties may vary with each venture, and here performance is generally individualized. The teams of complex agriculture are also likely to be loosely textured, since farming is often done by individuals, small family units (as in Western Europe), or under exploitative conditions of forced labor or peonage, as in much of the ancient world.

Thus, at the level of complex agriculture, strong social forces militate against the social solidarity that apparently leads to unforced, synchronous choraling. An exception that proves this rule is the complementary, village-based dance and song groups that once enlivened the work bees of Eastern Europe.

The Main Evolutionary Factors

An earlier study (3, pp. 199-200) established a strong correlation between the cohesiveness of a culture's performance style and both the stability of its teams and the level of its community solidarity. I feel justified in regarding the variance of factor 5, the level of cohesiveness (in song), as standing for the general adaptive importance of highly unified behavior. The way this factor varies along the evolutionary scale is shown in Fig. 4. This figure also shows the variance in the part played by women in the principal subsistence activity at each level of culture and the degree to which groups are integrated in organization at each level. These three curves follow more or less the

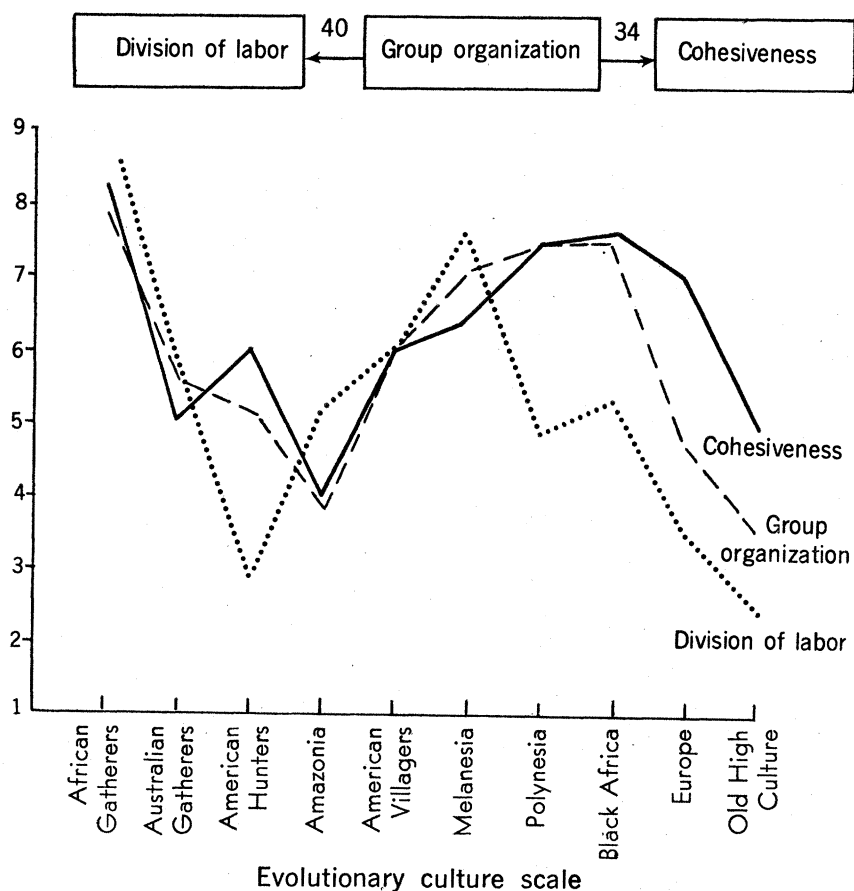


Fig. 4. The weighted means of three R factors are plotted along the evolutionary culture scale: division of labor by sex, organization of groups, and level of cohesiveness.

same regular, wavelike path along the evolutionary scale. Moreover, all three represent factors that are interlinked by the strongest residual bonds in the factor analysis of the measures (Fig. 4, top). These three factors seem to represent a single deep attribute of culture—the integrative tendency, which can best be observed by combining its three indicators.

Figure 5 shows how the combined weighted mean of integration varies in a clear, wavelike fashion along the evolutionary series and how this mean is related to the steadily mounting curve of differentiation. As I have already suggested, an intimate, though not direct, relation exists between these two general cultural characterizers. It has been pointed out that groupy teams are needed for many gardening tasks, while individualized teams are more suitable for hunting, fishing, and intensive agriculture. The sexual makeup of teams also changes with the main subsistence base of culture. Most gathering and gardening is relatively light work and takes place in moderate or warm climates; therefore, it can be performed by women, even if accompanied by their children. Extractive activities, except in the case of river and shoreline fishing, are often strenuous and hazardous operations, and are normally carried out by men—especially since, as main subsistence activities, they are usually confined to cold climates, where women must stay home to keep the children alive (7). A good deal of intensive agriculture, such as plowing with large draft animals, is heavy work for which male strength is usually required.

Although this is a sketchy account of a vast and important subject, it serves to show that the character and the sexual makeup of productive teams, as well as performing groups, change according to the requirements of the subsistence system. All the components of the integration factor shift together as subsistence teams of different sexual character, kind of organization, and type of leadership are fielded. These ongoing, diurnal demands profoundly affect the whole social fabric. For example, Barry, Child, and Bacon (8) have shown that child-rearing aims and practices change with the requirements of the subsistence system. Initiative is useful in the hunt, and therefore hunters cultivate independence in their sons, while farmers train their children in obedience. Moreover, it seems logical to suggest that family structure

should vary in relation to child-rearing needs and thus only indirectly in relation to societal evolution.

Many basic structural features of social and communication systems, however, do vary with the differentiation-integration pair. When the variance of all the factors of culture measurement is plotted along the evolutionary scale, the factors fall into three groups: (i) those that essentially go along with the differentiation factor, (ii) those whose variance follows the wavelike movement of the integration curve, and (iii) a miscellaneous group, whose even or indeterminate movements indicate that they play no clear part in the overall course of cultural evolution [Factors 6, 9 through 12, 14, and 6 through 19 (see box)]. It is notable that measures concerning the character of the family and the dimensions and structures of the kin group seem not to have a decisive relation to the overall course of species development as outlined in the evolutionary scale of culture. If this is not an expected result, it may be a logical one. Family and kin are human psychobiological constants, essential to all societies for ensuring the nurture of children and the emotional stability of adults. These institutions are, of course, subject to change, but only within a small range—perhaps because they are too fundamental to emotional security to vary in such drastic ways as the features of the integration factor. It appears, therefore, that those social scientists who have sought to chart the course of social evolution by studying changes in family and kin structure have been looking in the wrong direction.

In fact, two deep attributes (differentiation and integration) may be all that are needed to produce an evolutionary taxonomy of culture. The comparative study of world dance styles supports this supposition. When multifactor analysis was performed on 50 measures of movement style against a world sample of dance, only two factors emerged which varied in a unique and meaningful way along the evolutionary rank. (Five factors out of the remaining seven varied in a random way; two minor factors varied in the same way as the first of the two main factors.)

The first of these two factors clusters the differentiating, or manipulative, aspects of movement, and the second encompasses the erotic, feminine, gathering aspects of movement. The manipulative factor involves frequent

peripheral movement, varied movement, three-dimensional movement, light movement, and hand and foot synchrony. The sinuous factor involves frequent multipart trunk movement, trunk synchrony, successiveness, a flowing quality, trunk presentation, high synchrony, and curving movement.

Not only does this pair of factors correspond in many ways to the differentiation-integration pair, but they shift along the evolutionary rank order in a similar way (Fig. 6). The mean level of the manipulative factor rises in three stages along the evolutionary rank. These stages reflect an increase in light, varied, three-dimensional movement of the extremities of the body in dance, as manifested, for example, in the toe-dancing of Europe and the elaborate handplay of the Oriental dance. This body style symbolizes a complex and varied approach to the environment. As a matter of fact, all of the measures in the manipulative factor are highly correlated to elements in the differentiation factor.

The wavelike factor in Fig. 6 I term “sinuous” because it traces the mean level of scales that measure fluid, curvaceous movement, often involving the central body (pelvis, breasts, shoulders). All of these features, taken together, symbolize the feminine and the sexual. They are visible among African Gatherers and among Polynesians and Black Africans, where women are prime producers and where a feminine esthetic is dominant. The members of such cultures fall easily into synchrony with each other at a level that other cultures can scarcely achieve by intensive drill, probably because the sinuous movement style maintains a network of erotic signals that keeps interpersonal awareness high. It is, therefore, quite understandable that these qualities of movement should be prominent in those cultures in which people dance, sing, talk, and work together with a great deal of “natural and spontaneous” coordination. A high level of coordination has an adaptive function in these culture zones, as I have already argued.

It will be noted that this sinuous factor moves across the evolutionary rank in a wavelike path which resembles that of the integration curve. In fact, the two have highs and lows at most of the same points. That the behavior of these pairs of factors—differentiation-integration and manipulative-sinuous—should so closely resemble each other is all the more striking since the systems involved in measuring songs,

dances, and societies are based upon different sets of concepts, each set derived from the data being measured. Therefore, it is highly probable that these two pairs of factors measure the same pair of deep attributes of culture—two forces that shape all human behavior—practical, interactional, and expressive. The main events in human evolution can be explained in terms of the interplay of these two attributes—the differentiative and integrative-erotic, both equally important in social and communication systems.

Modern Evolutionary Trends

I now go beyond the data of ethnology, considered so far, beyond the stage of peasant agriculture and irrigation empire, and employ the evolutionary frame and the paired factors to illuminate some of the main features of industrial societies. In the first place, the differentiative factors continue their ascent (Fig. 5) as science and machinery multiply man's economic range. An expanding economy and growing population are accompanied by the rise of a monstrous administrative bureaucracy, along with an increase in the range, capacity, speed, and precision of communications media. The solo bards and the Salomes who entertained at court remain, becoming entertainment stars adored by millions. All this is familiar.

Less noticed is the fact that the coming of industry involves organizational changes that are reflected in an upward swing of the integration factor. In the stage of plow agriculture, women stayed largely in the harem, the home, or the garden, going out only in the company of chaperoning relatives or neighbors. Modern city life tends to break these ties or loosen their restraints. Factories and offices bring women back into public productive function, not at first as equals, but in an ever more complementary relation to men. Concomitantly, performance style grows steadily more multivoiced as musicians experiment with polyphony, accept African polyrhythms in jazz and rock, and, nowadays, habitually utilize multichannel recording. Certain forms of rock combine and integrate more independent musical levels than any other form of music analyzed by Cantometrics.

It is notorious that industrial production and distribution depend, above all, upon the synchronous meshing of many

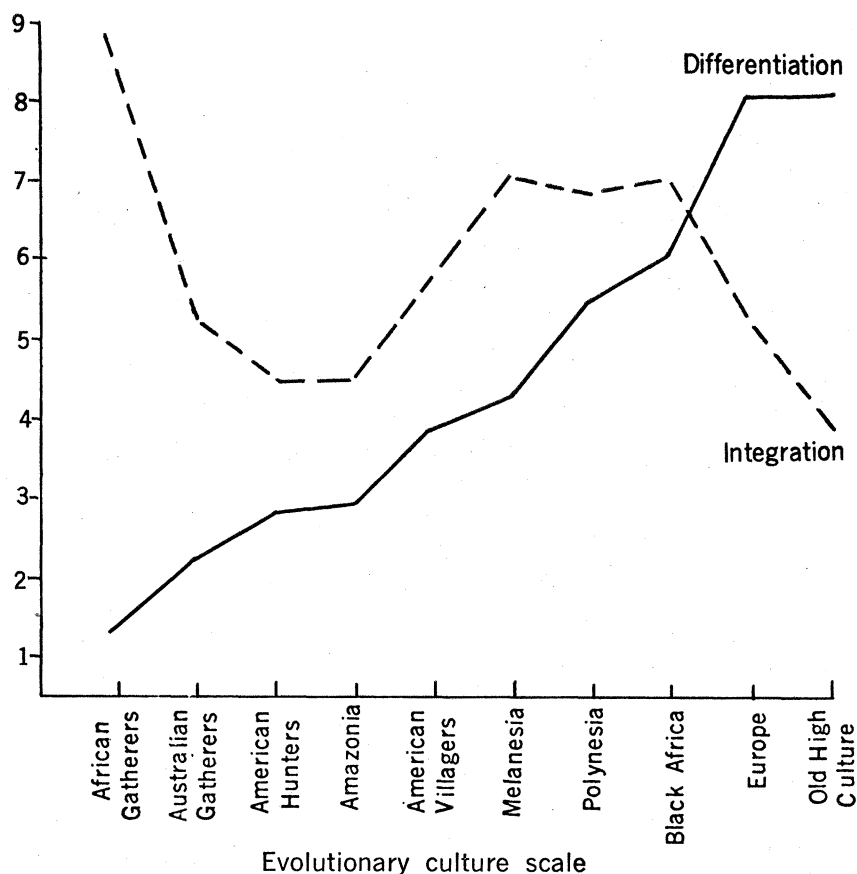


Fig. 5. The weighted means of the differentiative factor (solid line) and the integrative composite factor (broken line) are plotted along the evolutionary culture scale. These are the main factors from the 71 measures that were factored over the sample of 148 world cultures.

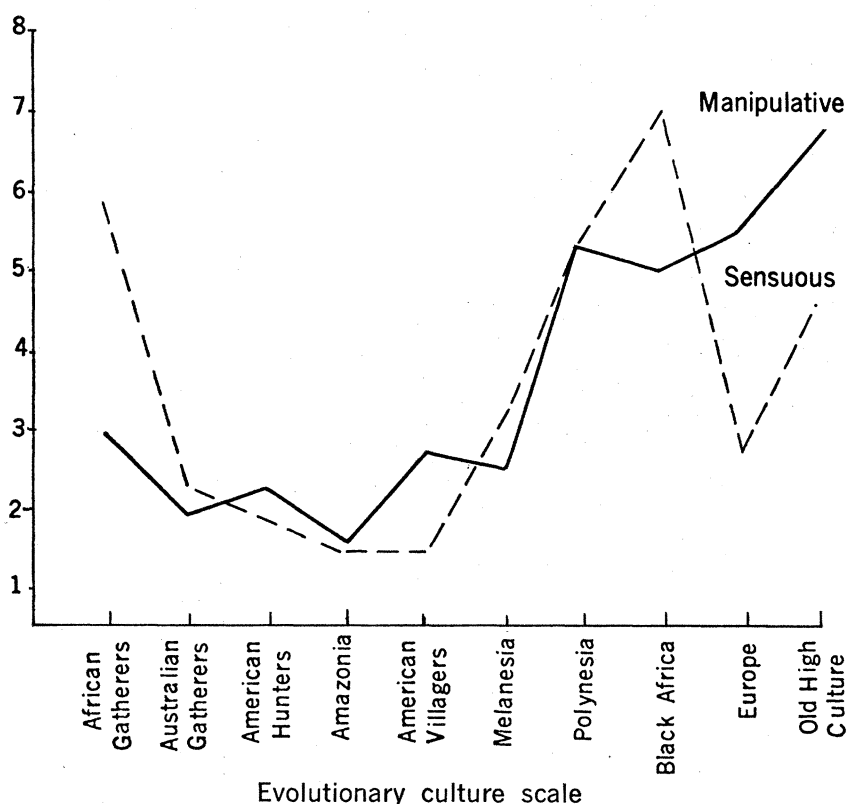


Fig. 6. The two main factors of the multifactor analysis of dance style are plotted along the evolutionary culture scale; 373 dance codings from 108 of the standard Murdock sample were used in this multifactor analysis.

systems. A symbolic parallel can be found in the ordered sections of the great 19th- and 20th-century symphony orchestra, which spread from Europe, across America, and into Japan, Australia, and now China, along with the industrial-managerial system which it reinforces. Not only the symphony, however, but marching bands, football, the ballet, and other massive demonstrations of multileveled coordination fascinate the people of industrial economies.

This recent trend in human evolution thus seems to indicate that culture is moving into a stage where a peak for integration will match an unparalleled high in differentiation. A somewhat similar situation prevailed once before in man's cultural evolution—in one of its earliest stages (9). The Mbuti Pygmies have apparently lived for many millennia in remarkable balance with their environment. The climate in their high jungle is moderate, mild, and healthful. Disease is rare, food is plentiful, and Mbuti society is permissive, egalitarian, supportive, fun-loving, and sharing. Their music is a kind of perfectly blended, joyous vocal counterpoint—the sound of a Golden Age that has somehow survived into the present. We moderns may now have a similar possibility, as predicted by these curves of the evolutionary process. After twenty millennia of blood, sweat, and tears, we have a technology that can reduce environmental pressures to a minimum, if it is administered properly. Man might again, like his remote African ancestors, live in balance with his environment, with all his needs provided for in a genuinely egalitarian, sharing society.

But let us return to the known, to some of the general conclusions that can be drawn from this comparative survey of the behavior of the human species. First of all, the record of living cultures demonstrates that, at the beginning of the evolutionary series, *Homo sapiens* lived mainly by gathering fruits, nuts, seeds, honey, tubers, grubs, rodents, and so on, rather than principally by hunting large animals. Thus it was not aggressiveness, but an understanding of the food resources of the terrain, and especially plant lore, that powered these nonauthoritarian, pacifist, collecting cultures. Recent studies of man's closest relatives among the great apes show that ape societies, too, are peaceful, highly intrasupportive communities that subsist principally by

gathering. Therefore, the thesis that man began as a bloodthirsty carnivore and an expert killer is a wish-fulfillment legend of armchair scientists that can go on the shelf with *Tarzan and the Apes*.

Indeed, if we can believe the evidence available from contemporary gathering societies, the earliest cultures flourished not because of superior aggressiveness, but because of the accumulation of economic and, especially, communicative know-how (7, 10). African Pygmies and Bushmen are famed wits and accomplished vocal polyphonists, their songs reflecting the harmonious internal balance of cultures that have endured since the dawn of human society. However, not only were the beginnings of culture rooted in cooperation and communication, but cultural progress has been marked, at every stage, by further development of technical, administrative, and, especially, verbal skills. I reemphasize the importance of vocal agility in human evolution since, before it was found to be an indicator of change, the very fact of cultural evolution remained in doubt. It is not yet clear whether languages can be arranged in a progressive series, but there can be no doubt of a rapid evolutionary development in systems for handling symbols. In fact, the close parallel between the manipulative and the differentiative factors suggests that every major human advance has been made possible by an increase in manipulative finesse. In sum, the progress of human culture is plainly reflected in the degree of differential control man brings to bear upon the whole spectrum of his activities.

Some people argue that advances in armaments have been the spur in evolution, but weapons are merely one of many kinds of tools. Other pessimists, looking back over the period of empire, from the days of Egypt to the end of the Chinese Empire, maintain that history is a sorry circle of the same greedy mistakes. But these writers confuse the history of one stage of human evolution, that of Old High Culture, with all of human history, which consists of at least ten main phases. In fact, the rise and fall of empire in classic times can be best viewed as the utilization of the resources of the Old High Culture phase by one people after another. Indeed, the rich possibilities of this stage of culture have only recently been exhausted. This interpretation permits us

to turn our backs on the gloomy view of man's history that has haunted us from the time of Gibbon and Hegel.

It seems clear that human culture has progressed in one positive respect. However, the process has been multilinear, as well as multileveled. Several branches of the human family have flowered in their own theaters of development, each producing an independent series of brilliant civilizations. Moreover, most of the 19 factors discovered in this analysis do not increase with the differentiation factor. More than half of them—those that concern family and marriage, melody and rhythm, for instance—seem to have only an indirect relation to cultural evolution. Other factors, having to do with male-female, face-to-face relationships in teams, move in response to the progressive differentiative factor, but along a contrary path. This important integrative factor, it will be recalled, draws together sexual division of labor, organization of groups, level of coordination, and sinuous and synchronous movement.

The interplay of the relatively independent factors with those bound directly and indirectly to technical progress gives human evolution a special, nondeterministic character. Each stage of technological development produces a syndrome of communication and organization that is, in its setting, a unique and ideal adaptive pattern. Each new combination of the basic structural factors with the other, less determined, factors gives rise to a new life-style. Each of these life-styles, both past and emergent, is a human universe, with its own logic and its own endless and unpredictable possibilities. Man, the most social of the animals, keeps on inventing cultures, each one capable of caring for people from infancy to old age. Each of these emerging patterns brings forth fresh human solutions and ideas of lasting value. Man's greatest achievement is here—in the sum of his cultural, his communicative know-how.

Only part of this know-how is encompassed in the differentiative factor, which has thus far been the spur to cultural evolution. In planning for the future of the entire human species, for the children of the more than 13 cultural subspecies, we must work with all aspects of culture, especially the much-neglected integrative factor, and we must also draw upon the full range of human solutions. Man's total heritage of life-styles can contribute to the

future, without giving precedence any longer to the European social and esthetic practices that accompanied the rise of industry. The varied styles of industrial society emerging today in China, Japan, Yugoslavia, the U.S.S.R., India, and Sweden only hint at the cultural variety that the future can bring forth as the character of cultural evolution is more generally understood. For almost a century, the intellectual atmosphere of the world has been poisoned by a false Darwinism that judged human social development as the survival of the fittest—that is, of the most successfully aggressive individuals and societies. This view can now be corrected.

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NEWS AND COMMENT

Technology in Vietnam: Fire Storm Project Fizzled Out

The Advanced Research Projects Agency (ARPA), which is attached to the Department of Defense (DOD) made at least three attempts, in 1965, 1966, and 1967, to light what defense planners termed “fire storms”—the name used to describe the World War II holocausts at Hamburg, Dresden, and elsewhere—in some of South Vietnam’s most valuable timber country. All three attempts, however, fizzled out. One may have even caused rainfall instead of a big forest fire.

The attempts were known by such euphemistic names as Sherwood Forest, Hot Tip, and Operation Pink Rose. They took place in the Mekong Terrace section of South Vietnam—a central plains area which contains several luxury timbers, such as mahogany and rosewood, and half of South Vietnam’s sawmills. Timbering is said to be one of the few industries that could develop into prime importance for the South Vietnamese economy. Nonetheless, experts from the U.S. Department of Agriculture (USDA) were called in by ARPA to advise on how to effectively burn the forests. The project’s budget was on the order of \$1 million.

Military sources say that the attempted jungle fires took place in areas where there were no “permanent type villages,” although they allow that Viet

Cong supply depots and base camps were in the woods. But Senator Gaylord Nelson (D-Wis.) views the fire projects as part of the U.S.’s “callous” and “unprecedented environmental warfare” which has involved “an outrageous use of technology.”

The USDA fire service role in the project was led by Craig Chandler, a fire storm expert who is now director of fire research for the Forest Service. The fire storm project is also discussed in a classified paper, obtained by *Science*, written by Arthur F. McConnell, Jr., a lieutenant colonel in the Air Force who was involved with the Ranch Hand defoliation missions.

Two reasons were given for the project. One was that, by creating a fire which would “crown,” that is, burn out defoliated tops of trees, the fire would remove layers of jungle canopy and make reconnaissance from the air more effective. A second reason was that a large-scale jungle fire which reached the tree tops would also destroy the ground cover and make concealment and camouflage by the enemy from U.S. bombing strikes or ground attack impossible.

Fire storms can be many times more dangerous than regular fires; they have occurred accidentally in forests in the American West, as well as in Australia

and southern France; they also occurred in urban areas, including Dresden and Hamburg, and on at least two occasions in Tokyo during a 1923 earthquake and during bombing raids in 1944–1945.

In a fire storm, the area of intense burning sucks in oxygen at such a rate that high-speed, cyclone-like ground winds are created, blowing into the fire at speeds which may exceed 100 miles an hour. The Hamburg fire chief, for example, reporting on the fire storm of July 1943, said that many people died from the intense heat even though they were located 150 meters from the nearest burning building.*

Both McConnell’s classified paper (which was later sanitized and published in the *Air University Review*†) and ARPA officials used the term fire storm to describe the burning projects in Vietnam. Chandler says he was asked on a number of occasions during the operation of the project whether a fire storm could be ignited in the humid, tropical jungle. Although lighting a fire storm might be feasible under certain conditions in temperate areas, such as the western United States, Chandler said he told the military it was not feasible to do so in the jungle.

Nonetheless, the fire storm project, as it came to be known, was started under ARPA authorizing order 818. Its final reports are all classified, although some press reports appeared at the time of the attempts. Chandler said he was

* “Field notes on World War II German fire experience,” title of contract No. N228(62479)-65419 to Carl F. Miller and James W. Kerr, October 1965, Stanford Research Institute, Menlo Park, Calif.

† The sanitized version was published as: A. F. McConnell, Jr., “Mission: Ranch Hand,” *Air Univ. Rev.* 21, 89 (1970).