Cultural Diversity Tied to Genetic Differences

Genes and culture are inseverably linked, argue two Harvard researchers. Cultural differences may therefore be genetically based, they say

There is nothing modest about *Genes, Mind, and Culture*.* Harvard biologist Edward Wilson has been joined by Charles Lumsden, a theoretical physicist from Toronto, in writing a book that they claim is "the first attempt to trace development all the way from genes through the mind to culture." Their theory of gene-culture coevolution "is designed to include all cultural systems, from the protocultures of macaques and chimpanzees to the euculture of human beings, as well as forms of culture hitherto conceived only in the imagination."

The theory of gene-culture coevolution puts human culture under a much tighter degree of genetic control than most anthropologists and social scientists will feel comfortable with. It brings together cell biology, psychology, evolutionary biology, and behavioral sciences in unfamiliar apposition. A mathematical model of the theory generates predictions that are certain to be controversial. Among more than a dozen biologists contacted by *Science*, the book has been described variously as "marvelous . . . a once in a century occurrence" and "seriously flawed and dangerous."

Wilson describes the new book as an attempt to fill an important gap left by sociobiological theory. "After the political wars over sociobiology had abated, it became clear that two major objections raised by philosophers and social scientists were valid. One is that sociobiology has no conception of where the mind comes from and what free will means. And the other is that the theory has no adequate explanation of the remarkable diversity of cultures."

Gene-culture evolutionary theory not only explains these phenomena, claim its authors, but it also implies that genetically underpinned cultural patterns evolve surprisingly rapidly. Fifty generations, 1000 years, is said to be sufficient for important genetic shifts, even with modest selection. The results of the model therefore suggest that since the advent of agriculture some 10,000 years ago, "time has been more than adequate for substantial coevolution and the establishment of some degree of epigenetic bias in virtually every category of cultural behavior," write Lumsden and Wilson. The proposed "thousand year rule" therefore places important aspects of human evolution firmly within a historic rather than a geologic time frame.

Lumsden and Wilson first met toward the end of November 1978. Wilson had recently written *On Human Nature*, the sequel to *Sociobiology: The New Synthesis*. He was emerging from a period of much public excoriation over the social and political implications of sociobiology. There began 2 years of intense collaboration, starting initially with thoughts on insect societies but soon shifting to human culture. "We were both convinced that the relationship between genes and culture was one of the key outstanding problems in scientific investigation," says Lumsden. "It wasn't just a question of missing detail, of filling in a few gaps. There was a major hiatus that required a conceptual breakthrough." Wilson comments that the no-man's-land between the biological and social sciences "is not likely to be an area that is easily traversed."

This territory is, however, not totally unexplored. A number of research groups have ventured into this area, many of them equipped with sophisticated mathematical models. Probably the most thoroughly developed approach is that of Stanford researchers Luigi Cavalli-Sforza and Marcus Feldman, who have just published a book called *Cultural Transmission and Evolution: A Quantitative Approach*. In their book, Lumsden and Wilson acknowledge the Stanford model as "a step in the right direction." In conversation Wilson describes it as "timid." Without doubt, the Lumsden-Wilson presentation is far bolder in its conclusion than that of Cavalli-Sforza and Feldman. It also leashes together genetic and cultural evolution in a way that no other model does.

The basics of Lumsden and Wilson's coevolutionary theory are as follows. Culture is viewed as a particulate phenomenon, the units of which are termed culturgens—that is, a particular marriage custom, a religious belief, preference for sweet as against bitter tastes, and so on.

An individual's choice between alternative pairs of culturgens—to wear a beard or to go clean shaven, for instance—is determined by two factors: genetically determined epigenetic rules, which govern the perception and cognitive processing of information, and the proportion of individuals in the population who have made one choice over the other. Cultural patterns that characterize a population are the sum of individuals' selections over all culturgens.

The theory assumes that some cultural practices are more beneficial to survival than others and are thus susceptible to the laws of natural selection. Because of the inseverable relation between genes and culture envisaged by Lumsden and Wilson, selection is seen as acting on more than just the overt cultural behavior: the genetically determined epigenetic rules underlying choice of culturgens are also subject to selection. The coevolutionary circuit is thus complete.

In brief, that is the theory. How does it work in practice? Four classes of evidence are required to demonstrate that humans do indeed engage in gene-culture interaction, according to Lumsden and Wilson. First, epigenetic rules must be shown to exist. Second, there must be genetic variance in epigenetic rules within human populations. Third, a link must be demonstrated between cultural practice and genetic fitness. Fourth, it must be shown that molecular and cellular mechanisms directly connect genes with cognitive development.

Epigenetic rules, suggest Lumsden and Wilson, fall into two categories. Primary epigenetic rules are "the more automatic processes that lead from sensory filtering to perception." The consequences of these rules, say Lumsden and Wilson, are the least subject to variation due to learning and other higher cortical processes. Secondary epigenetic rules act on all information displayed by the perceptual fields. "They include the evaluation of perception through the processes of memory, emotional response, and decision-making through which individuals are predisposed to use

**Genes, Mind, and Culture*, by Charles J. Lumsden and Edward O. Wilson, published by Harvard University Press, May 1981. $20.

0036-8075/81/0522-0908$00.75/0

certain culturgens in preference to others."

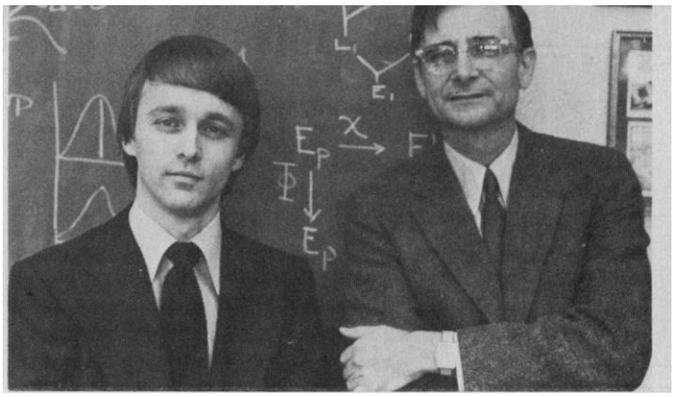
The best examples of primary epigenetic rules, claim Lumsden and Wilson, are in taste and smell, color classification, and hearing. "Many social scientists used to believe that the divisions into red, green, and so forth, are arbitrary," they write, "but linguistic and cross-cultural studies have shown that they are in fact closely tied to natural color perception." Similarly, constructs of the world are constrained by the physical limitations of taste, smell, and auditory perception, they argue.

Secondary epigenetic rules are inevitably more complex—involving feature discrimination, storage, interpretation, recall, and computation—and more susceptible to variation through learning. One of the clearest examples, according to Lumsden and Wilson, is "the nearly universal avoidance of marriage and full sexual relations between brothers and sisters." They suggest that the secondary epigenetic rule operating here is well established and especially tractable to analysis: "a deep sexual inhibition develops between people who live in close domestic contact during the first 6 years of life."

A second example discussed at some length is the fissioning of Yanomamo villages when they exceed a certain size. "Beyond a critical village size, aggression and strife become unbearable to a sufficient number of village members to induce emigration by part of the population. . . . However, this pattern of responsiveness depends on the size of the group. Thus the epigenetic rules are context dependent." Other behaviors in which secondary epigenetic rules may be identified, say Lumsden and Wilson, are nonverbal communication, fears and phobias, and child holding.

The second class of evidence—for genetic variance in epigenetic rules—also receives an affirmative. "Pedigree analysis and standard comparisons of fraternal and identical twins . . . have yielded evidence of genetic variance in virtually every category of cognition and behavior. . . . These categories include color vision, hearing acuity, odor and taste discrimination, number ability, word fluency, spatial ability . . . psychomotor skill, extroversion, introversion, homosexuality, proneness to alcoholism, . . . certain forms of neurosis and psychosis, including manic-depressive behavior and schizophrenia, and others."

In order to support the third requirement, Lumsden and Wilson adduce "certain practices in tattooing and other modes of body marking, as well as in circumcision, treatment of menstrual and afterbirth blood, and diet, . . . sexual practices, marital customs, early mother-infant attachment, differential infanticide, formalized techniques of aggression, and economic organization . . . ." These practices influence genetic fitness, they say, although "the long-term effects of such practices have not been measured."



Charles Lumsden (left) and Edward Wilson

Lilian Kemp Photography

"Genes inaugurate programs of growth and migration and the general rules of neuron interaction that lead to brain ontogeny," write Lumsden and Wilson. It follows therefore that "relatively few genes [can] shape salient features of important brain structures and psychobiological responses." They report single gene mutations that are associated with dramatic neuroanatomical and behavioral disruptions, both in experimental animals and humans, thus supporting their fourth and final condition.

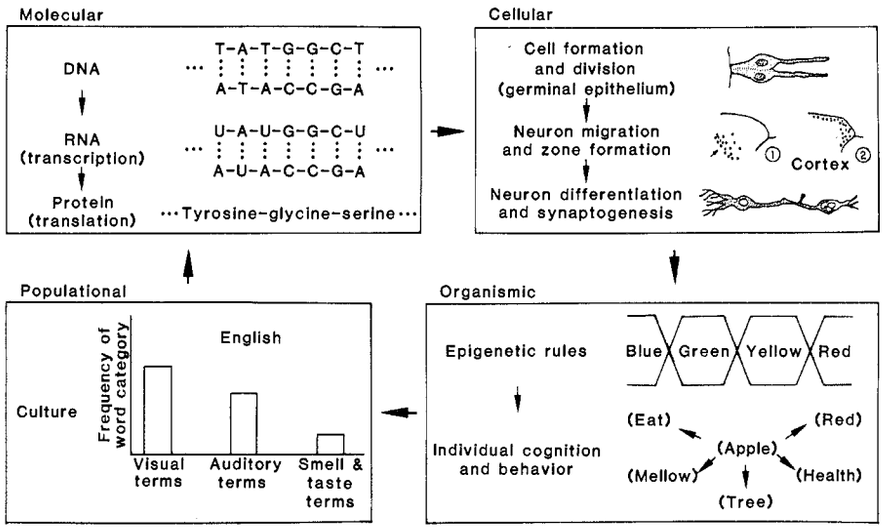
When Lumsden and Wilson move from theory to model, they use equations borrowed from the physics of interactions in dilute gases to construct a model that is meant to encapsulate human culture. Two important results emerge from the mathematics. The first is the amplification law, which says that "a barely detectable amount of selectivity in an epigenetic rule operating during the behavior of individuals can strongly affect social patterns." This law, which was foreshadowed in Wilson's *Sociobiology: A New Synthesis*, makes a relatively small degree of genetic variation between populations compatible with great cultural diversity that is to some degree prescribed by genes.

The second, and most controversial, result is the already mentioned thousand year rule. "The conventional view is that significant genetic evolution requires thousands of years and largely came to a halt in human populations 30,000 years ago or more, after which cultural evolution took over as virtually the sole agent of change. But the coevolutionary model shows that substantial genetic evolution of behavioral traits can occur within only 1000 years and is very likely to have proceeded right into modern times. The conventional view also sees genetic variation in cognitive ability and perceptual and motor skills as noise, the result of random fluctuation around the species norm. But the coevolutionary model reveals that . . . the genetic variability of human beings is part of an adaptation that has resulted in a more efficient functioning of society." In conversation Wilson emphasized the meaningfulness of genetic variation. "These differences," he says, "make us more human."

What has this whole enterprise achieved? "We believe that this theory opens a new realm of sociobiology and, through it, introduces a mode of evolutionary analysis that will lead to a deeper and more precise understanding of human behavior. . . . Although *Homo sapiens* is the most complex species on earth by a spectacular margin, it is probably far less complex and difficult to understand than contemporary social theory leads one to believe," conclude Lumsden and Wilson.

Although Wilson stresses that the collaboration has been "straightforward science—we tried to do it without worrying about the implications." Lumsden sees potential for "social planning and control." One practical benefit, he suggests, is in psychopathology. "If we understand how the epigenetic rules work," Lumsden says, "then we understand a lot more how the human mind develops at different stages, and how it might go wrong. In these circumstances it will be possible to steer the mind back, so that the individual is happier in the cultural context in which he finds himself." Lumsden recognizes that this is "potentially explosive" but insists that "it is not social engineering."

Genes, Mind, and Culture is certain to attract a good deal of attention, because Harvard University Press is promoting it unusually vigorously for what essentially



The coevolutionary circuit

Genes underlie the establishment of neuronal structures; these structures set the primary and secondary genetic rules at the organismic level; the sum of individual choices shapes overall cultural pattern; selection favors certain traits and, therefore, certain genes.

is a research monograph, and because Edward Wilson's name is attached to it. But how sound a contribution is it? Robert Fagen, who studies play at the University of Pennsylvania, describes the book as "an important milestone in the analysis of human behavior." He is particularly impressed that the theory incorporates cognitive development in the shaping of culture. He likes the idea that the thousand year rule releases us from the notion that humans have to cope with the modern world with the brains of primitive hunter-gatherers in our heads. Although he sees great potential application of the theory in the world of business affairs, he suggests that it is more limited when faced with international politics. Fagen describes himself as "a believer."

Paul Harvey, a sociobiologist who until recently was at Harvard, says that "somebody has to think about genes, culture, and evolution. It's a genuine scientific endeavor, and their effort is laudable." Harvey, however, is uneasy about it. "The level of mathematics compared with the level of biology in the second half of the book seems to lose control. . . . I don't know quite what I'm being told." There is an astonishing arrogance in the strength of the assumptions, suggests Harvey, "and this is dangerous because neither of them is an expert on culture."

Complaints that the book's mathematics frequently does not match the text and that the theory encompasses an inappropriate view of culture were persistent refrains in the comments of people contacted by *Science*.

"They go through a series of arguments, say from the psychological literature, that have established biases in them, and then they draw conclusions that are not the only valid ones," comments Ronald Pulliam, a mathematical biologist at the State University of New York at Albany and coauthor of the recently published essay on the evolution of culture, *Programmed to Learn*. "And if you go through their math carefully you find that it doesn't always say what the text says. . . . This is a common fault with modeling of this sort." When the Lumsden and Wilson book is compared with the Cavalli-Sforza and Feldman book Pulliam says, "The two err on opposite sides: Cavalli-Sforza and Feldman do an excellent job of developing the theory and then do too little with it, while Lumsden and Wilson do not develop their theory as well and then are far too incautious in their conclusions."

Richard Lewontin is a population geneticist on the floor below Lumsden and Wilson at the Museum of Comparative Zoology at Harvard. Lumsden and Wilson did not consult Lewontin because, says Lumsden, "he's not equipped to comment authoritatively on the work." Lumsden and Wilson's reluctance to approach Lewontin might also be related to the latter's reputation as a vigorous critic of the often brash application of sociobiology to human affairs.

"Because of the nature of the struggles there have been over sociobiology, many people will not come out and say what they really think about this," observes Lewontin. This prediction proved correct. A number of people well placed to comment on the work declined to go on record with their criticisms. A disturbingly loose fit between the model and the world it is meant to reflect was, however, the principal theme.

"There are serious flaws in the mathematics that can be understood only in relation to the whole corpus of sociobiology," claims Lewontin. He suggests it amounts to "mathematical obfuscation." Lewontin describes the model as procrustean: "it is cut and stretched to fit a preconceived idea." Pulliam's remarks echo this criticism: "This is common in the nature-nurture debates when people have preconceptions."

Geneticists, says Lewontin, are very naïve in what they mean by culture. William Irons is an anthropologist at Northwestern University, and he confesses to being "very skeptical that culture can be modeled in the way Lumsden and Wilson do, that is, treating it as a particulate phenomenon." He points out that people move between societies and change their behavior radically. "This conflicts with the idea that their behavior is genetically guided in any important way."

One of the important case studies in the book—fissioning in Yanomamo villages—drew on the work of anthropologist Napoleon Chagnon of Pennsylvania State University. "The theory makes an important step in that it ties cultural development to cognition," he says, "but overall it makes me uneasy. It is so highly mathematical and complex. I read my own work, and I found it very difficult to know what they were talking about. And I know those Indians. It seems to be too far removed from biology."

The mathematics will undoubtedly deter many readers whose principal interest is in the social and cultural spheres. "There's a problem that these people will mistake the math for rigor," cautions Harvey. Pulliam is worried about Lumsden and Wilson's suggestion that nonmathematicians can navigate through the arguments by simply reading the specially prepared summaries and sign posts. "This is dangerous because of the mismatch between the math and the text," he says.

The remarks of John Maynard Smith, an evolutionary biologist at the University of Sussex, England, are perhaps the most telling. "It's not clear that a particulate theory of cultural transmission is very useful," he says. He is prepared to have this view reversed if the facts are persuasive enough. But he doesn't expect this to occur. "It's not that the theory is racist or sexist or anything like that. I just believe theirs is a simplistic concept of the cultural process."

—ROGER LEWIN