# Cultural Evolution and the Shaping of Cultural Diversity

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# Introduction

This chapter focuses on the way that cultures change and how cultural diversity is created, maintained and lost. Human culture is the inevitable result of the way our species acquires its behavior. We are extremely social animals and an overwhelming proportion of our behavior is socially learned. The behavior of other animals is largely a product of innate evolved determinants of behavior combined with individual learning. They make quite modest use of social learning while we acquire a massive cultural repertoire from the people we associate with (Richerson & Boyd, 2005: Chapter 2). Expertise in exploiting our environment, values about what matters in life and even feelings about whom to trust and whom to hate are mostly "absorbed" from those around us.

What's more, we are very adept at transmitting cultural information to others, sometimes through frank teaching but also through the constant social interaction characteristic of human life: mutual observation and casual conversation during which behaviors and beliefs are seen, described, evaluated and generally gossiped about. As Rogoff (2003) notes, in traditional cultures teaching is not like formal schoolwork or the school-like teaching seen in modern societies and families. Children learn by close observation followed by concrete participation in the activities of everyday life, gaining greater participation as they master more complex skills. Adults teach in the sense that they tolerate children's participation and lightly guide and structure children's learning experiences.

Cultural diversity inevitably develops in the course of cultural transmission. Individuals are constantly misremembering and thus varying some piece of culture, as well as making more deliberate variations. Learners will often put their own personal twist on what they have been taught. Once such a new "cultural variant" exists, there will be a tendency for it to be preserved. A woman's children may pick up a variant she created and spread it among their friends at school. They might then pass it on to their families. If such cultural processes were all that were operating, cultural diversity would increase without bound. In fact, although cultural diversity is great, it is not boundless. Other social processes operate to select and winnow away less useful cultural variants. This results in members of the same culture and sub-culture sharing a large proportion of their cultural information.

The sharing of cultural information allows groups of humans to interact and cooperate effectively so it is essential that some processes act to limit diversity. If such processes did not exist, human societies could not function as they do. Languages and dialects are the canonical examples of shared cultural information. For members of a social network to be able to communicate, their vocabulary and grammar has to overlap to a large extent. Thus, conformity to common usage acts powerfully to limit linguistic diversity. Variation in language usage does exist at the individual level, but the bulk of the variation is concentrated between communities which, historically, had little reason or opportunity to communicate with one another. When groups do not interact, their languages evolve separately and, in time, become mutually unintelligible. Linguistic conformity and diversity is especially important in explaining patterns of cultural change because so much cultural transmission involves

language and much cultural variation thus follows patterns of linguistic variation (Pagel and Mace, 2004). Of course, the spread of cultural variants can defy linguistic barriers, especially in the current "global village"; a great majority of the world's people know that Coca Cola is a soft drink and that a Big Mac is a certain American-style meat sandwich. However, as a general rule, cultural diversity between communities must exist because some tools, techniques and economic practices are suited to the situation of a given community and some are not. As cultures change, they adapt, with less successful cultural variants being forgotten or modified.

Our objective in this chapter is to dissect the process of cultural change, and the divergence and merging of cultures by describing the complex concatenation of forces that shape cultural diversity – forces which, for example, act to wipe out whole languages and technologies while constantly spawning new dialects and new technologies. We draw a number of qualitative inferences from theory and available data, but the quantitative study of the dynamics of cultural diversity is still in its infancy.

The current pattern of cultural diversity among our species is the result of the changes in the knowledge, practices and beliefs that have occurred over the last 70,000 or so. Genetic evidence revealing how closely related all modern humans are suggests that we are descended from a relatively small population with limited individual and sub-cultural variation (Harpending et al., 1998). Between 50 and 100,000 years ago this population began to grow and spread, first in Africa and then across the world. With this expansion came a diversification of their languages, subsistence systems, patterns of social organization, and other cultural features. As more complex societies began to evolve about 5,000 years ago, subcultures—classes, castes, occupational groups, religious faiths—began to diversify *within* cultures to a degree not seen in earlier tribal scale societies. Meanwhile the growth of complex societies began to sweep away the former diversity *between* small-scale societies. The many elements making up the vast body of information comprising a population's culture can each change in a variety of ways, so the potential for creating new combinations of ways of perceiving and interacting with the physical world are staggering. On top of that, there are many possible variations on how to define social interaction, interaction with the biological environment, and so on.

We are not aware of any comprehensive attempt to quantify cultural diversity and its change through time although many partial catalogues exist (e.g. Fearon, 2003). Jorgensen's (1980) classic study of the ethnographic diversity of Western North American Indians analyses the patterns of covariation to be found among the different dimension of culture in his dataset. Cultural anthropology textbooks use various simplifying schemes to sketch the spatio-temporal patterns of diversity (Johnson & Earle, 2000). The Human Relations Area Files is a large database of ethnographic and historical data from which many studies have been drawn (Murdock & G.P, 1967, http://www.yale.edu/hraf/).

A number of researchers have begun to attempt to infer the history of related groups of peoples by employing the methods used biologists to determine the evolutionary descent of species (L. L. Cavalli-Sforza, 2000; Holden, 2003; Moylan, Graham, Borgerhoff Mulder, Nunn, & Håkansson, 2005; Pagel & Mace, 2004). These studies are often based on linguistic data; we probably know more about language change and

diversity than about any other segment of culture (Nettle, 1999), except perhaps technology (Basalla, 1988; Needham, 1987). The Centre for the Evolutionary Analysis of Cultural Behavior based at University College London is beginning the project of constructing quantitative databases of archaeological data (http://www.ceacb.ucl.ac.uk/home/) but, as with biodiversity, the many dimensions of cultural diversity defy easy analysis (Dunn, Terill, Reesink, Foley, & Levinson, 2005).

Our approach to describing cultural change is to view it as an evolutionary process. However it is important to first point out that we do not use the word "evolution" in the sense first used by the nineteenth century founders of anthropology to mean "progress" from less complex to more complex societies (Burrow, 1966). We use it in the sense used by Darwin. Just as people acquire their genes from their parents, they acquire their culture from the people they encounter. They model their behavior on that of significant others in their lives. These cultural "models" may actively communicate values, skills and information, they may be passive objects of imitation or emulation or they may play some intermediate "teaching" role (Rogoff et al., 2003). Whichever way transmission occurs, the models from whom an individual acquires his or her culture are limited in number, a small sample drawn from the larger population. In principle, any individual might learn some element of culture from any other individual in the world but, in practice, we usually model our behavior on the behavior of limited number of people from our own culture and sub-culture. In principle, an individual can invent a completely novel and personal body of knowledge, beliefs and values but in practice people make only marginal changes to the culture they inherit from others.

The transmission of culture between individuals is the engine of cultural replication and change but, for the most part, what any one individual member says or does has little impact on the process of change. Culture and cultural change is best viewed as a population level phenomenon. Single individuals are largely prisoners of the culture they inherit but the decisions they make and the outcomes of those decisions are what drive cultural evolution. Summed over a *population* of individuals and over some span of time, some culturally characteristic behaviors, beliefs and values become more common in the population, some become less common and some disappear altogether. New cultural characteristics arise and either "survive" and spread through the population, or they fade away.

Thus, the all-important population level phenomena of cultural evolution that we will describe here emerge from the aggregation of myriad events and decisions at the individual level. A long tradition of social, cognitive, and developmental psychological research provides us with a basic understanding of cultural transmission, of how information is learned and processed and how cultural norms are adopted and developed by individuals and groups (e.g. Asch, 1951; Bandura, 1986; Bloom, 2000; Festinger, Schachter, & Back, 1950; T.M. Newcomb, 1943; T. M. Newcomb, Koenig, Flacks, & Warwick, 1967; Rogers, 1995; Sherif & Murphy, 1936; Michael Tomasello, 1999). Cultural psychologists, by investigating the degree of diversity between and within populations, observe the effects of cultural variation on behavior.

A massive gulf exists between the individual level social interactions during which cultural variants are acquired and modified and the long-term population level changes in that cause two groups of people to become "culturally different". However this gulf can be bridged by methods developed by population geneticists to study genetic evolution. Viewed at the population level, "Culture" (i.e. the pool of cultural information associated with a population) has a certain formal similarity to the pool of genes associated with a species. Theorists have therefore capitalized on this similarity to create mathematical models of the cultural evolutionary process (e.g. Boyd & Richerson, 1985; Luigi L. Cavalli-Sforza & Feldman, 1981). Evolutionary biology also furnishes inspiration for empirical investigations of cultural evolution (Baum, Richerson, Efferson, & Paciotti, 2004; Insko et al., 1983; Jacobs & Campbell, 1961; McElreath et al., in press).

In other words, applying these methods provides the opportunity to investigate cultural change in much the same way that changes in the composition of a population's gene pool can be investigated. Studying culture in this way is not "biological reductionist" in the sense that it relies on an assumption that individuals are biologically determined to acquire specific behaviors (Richerson & Boyd, 2005). What it does rely on is the assumption that humans are genetically adapted to acquire some of the cultural characteristics of the people they associate with. Few would disagree with this. Undoubtedly genes play some role in the directions in which cultures evolve but this role is limited. For example, the human senses of taste and smell undoubtedly places constraints on the evolution of diets but this is far from deterministic. Many cultures have evolved cuisines in rich spices and aromas that generate alarm and disgust in the "untutored" palate. In the very long run, cultures actually create the environments to which its members must adapt genetically. This leads to the coevolution of genes with culture.

The main purpose of theoretical models of cultural evolution is to investigate the large-scale and long-term consequences of the aggregate of individual level events. However, cultural evolutionary analysis can also be performed in reverse; given a characteristic, such as the human propensity to cooperate in large groups of distantly related people, models can help to investigate what sorts of individual level properties might give rise to such an outcome. Only in the simplest cases is this exercise trivial. By using mathematical models to create predictions about cultural evolution which can then be tested, cultural psychology will more fully develop its potential as an experimental science.

Evolutionary analysis of culture provides an answer to the commonest criticism leveled at cultural explanations of human behavior – that it is not actually explanatory. The suggestion that people behave according to the dictates of their cultures is little more than description and many social scientists are more impressed by the power of explanatory systems like economics and behavioral ecology which allow deep causal analyses of human behavior. The fact that cultural variation exists is important in its own right but these social scientists also want to explain how the variations arise. Cultural evolution undertakes to provide this explanation. The basic format of evolutionary analyses is a virtuous circle. Individuals in one sense are prisoners of their cultures. What we believe, how we behave, etcetera are largely based on what we acquire from our culture. But, at the same time, our decisions about which elements to adopt of the culture we encounter and the effects of those decisions

upon our lives, are the most important motors of cultural diversification. In the long run, culture is shaped by the actions its individual members and the consequences of those actions.

Evolutionary theory and empirical studies allow us describe the behaviors and processes that maintain and destroy cultural variation. We will review this work, with an emphasis on contemporary cultural change. Losses of cultural diversity due to the apparent assimilation of smaller cultures and the "globalization" of some aspects of culture are often noted. On the other hand, new variation is arising and many old variants stubbornly resist conversion to modernity. Commentators commonly express the fear that cultural change in the modern world will inevitably lead to homogeneity as the members of smaller cultures are assimilated into larger ones. We will argue that the processes of cultural evolution will ensure that cultural diversity is maintained. The pattern of cultural diversity has changed and is likely to change further, however, so that culturally different groups become less distinct.

## The capacity for cumulative culture

For the last 30 years or so, most of the scholars who have applied Darwinian thinking to human behavior have investigated the evolution of psychological mechanisms acquired via the genetic rather than the cultural inheritance system. Insights developed in the 1960's and 70's into how natural selection acts on behavioral genes (Hamilton, 1964; Trivers & Robert, 1972; R. L. Trivers, 1971; Williams, 1966) led to a revolution in our understanding of the reproductive and social behavior of non-human animals and have formed the theoretical basis of many investigations of human behavior. The idea that evolved psychological mechanisms interact with environmental circumstances to produce specific behaviors inspired many testable hypotheses and much fruitful science has been accomplished (e.g. Buss, 1999; Cronk, Chagnon, & Irons, 2000) but inevitably, the extent to which such studies can explain human behavior is limited.

Humans undoubtedly possess many genetically evolved psychological mechanisms which allow us to make sense of the environment and which structure the ways we perceive information from our senses. We share many of these cognitive capacities with other animals. But among the evolved mechanisms that are unique to humans, the most important must be the ones that govern the way we acquire, use, modify, abandon and pass on cultural information. Behavioral characteristics acquired through our genetic inheritance cannot begin to explain the complexity and diversity of human behavior. Humans thrive in a wide variety of natural habitats, consuming a wide variety of diets and constructing a complicated variety of social systems. Yet among the six or so billion humans worldwide there is far less *genetic* diversity than among the fewer than 200,000 chimpanzees occupying African forests (H. Kaessmann & Paabo, 2002; H. Kaessmann, Wiebe, & Pääbo, 1999; Tamura & Nei, 1993).

The classical explanation for greater diversity of human behavior is that individual humans *learn* behavior from one another rather than relying on instinct. This is also too simplistic. Animal species as diverse as rats, pigeons, and fish, as well as chimpanzees, have been found to acquire behaviors through social learning (Moore,

1996). Once a behavior exists in a population, the likelihood increases that the behavior will be exhibited by members of subsequent generations. This can result in persistent differences between the behaviors observed in separate groups of animals. Such behavioral diversity, which cannot be explained by genetic or environmental differences is, by many definitions, evidence of culture (Byrne et al., 2004). Comparisons of the behaviors observed in the six most widely-studied chimpanzee populations revealed that each community possesses a distinctive repertoire of behaviors which, if observed in human populations would be reported as cultural differences (A. Whiten et al., 1999). However, the chimpanzee cultural repertoire is very limited compared to the powerful technologies and complex institutions that characterize human cultures.

Human cultures are more complex because they are the product of many generations of *accumulated* cultural change. The culture of other animals—even of chimpanzees—show at most very modest signs of cumulative improvement (Boyd & Richerson, 1996). Useful behaviors may be acquired through social learning but these are all behaviors which the individuals could, and often do, learn on their own. In human cultures, by contrast, each newborn member has access to a vast body of knowledge and know-how that is far greater than a single individual could learn by experience, even in several lifetimes of experience. Learning and invention enables individuals to contribute to the body of cultural knowledge, but no one starts from scratch. Just as *genetic* evolution is the accumulation of small changes in *genes*, which gave an advantage to the organisms that carried them, *cultural* evolution is a process that allows useful *cultural* variants to be acquired, improved upon and then passed on. Small success builds on small success.

Experimental studies comparing human and chimpanzee abilities to acquire behaviors by social transmission show that we are the more adept imitators by a large margin (M. Tomasello, 1996; Andrew Whiten & Custance, 1996). The behavior of apes who have observed a demonstration suggests that they rarely copy a precise procedure but are inclined to use it as a guide to developing their own solution to a problem (Andrew Whiten & Custance, 1996). Children, on the other hand, are such faithful imitators that they have been found to persist in using a demonstrated technique for obtaining a reward which apes soon abandon for a more efficient method of their own devising. Many years of observing chimpanzees in the wild has yielded little evidence of what might be construed as one chimpanzee trying to tell another something useful (Byrne, 1995), however, for a more generous interpretation of chimpanzee social learning see (Boesch, 2003). High fidelity imitation and evaluative communication or teaching (Castro & Toro, 2004) seem to be a derived package of cognitive and motivational traits that provide the psychological foundation for our complex cultural repertoires.

Cultural diversity in humans grows directly out of the cumulative evolution of complex cultural repertoires. Part of this diversity is due to historical happenstance. Cultures evolve in partial isolation and tend to diverge from one another as small differences accumulate generation by generation. The purest examples are from the symbolic part of cultural repertoires, such as language (Bettinger, Boyd, & Richerson, 1996; Labov, 2001; Logan & Schmittou, 1998; Nettle, 1999; Thomason, 2001) while variants such as technical skills are influenced by environmental factors. When populations live in different habitats, adaptive processes of cultural change lead to

diversification because variants appropriate to the respective habitats are most likely to be adopted. Adaptive cultural change can, of course, also lead to convergence when populations live in similar environments (Johnson & Earle, 2000). Groups that make their living in a desert will likely develop some similar practices whether the desert is in Australia or Tunisia. However, adaptive processes also leave ample room for historical factors that maintains variation between populations even if their survival problems are similar. Complex cultural adaptations can vary along many dimensions. The "design topography" is probably quite rough and likely to lead to many local optima. For example, the problem of carrying and storing water can be solved in a number of ways and a culture which has already developed the skill of weaving waterproof baskets may never acquire the technology for producing pottery and vice versa. Partially isolated cultures will evolve along different trajectories even if the only processes operating are adaptive and deterministic (Boyd & Richerson, 1992a).

An ability and desire to influence and be influenced are important elements of the psychological processes that govern the transmission of cultural information but, again, there are more complexities. If the transmission of cultural information were simply a matter of demonstration by those who are knowledgeable and faithful copying by those who are naïve, cultural evolution would be slow and very similar to biological evolution. Copying errors would be the only source of variation and variants would be selected by natural selection alone. Cultural evolution is rapid and allows rapid adaptation because the human capacity for culture includes psychological mechanisms that enable individuals to introduce variation and make better than random choices between the cultural variants they are exposed to (Durham, 1991; Richerson & Boyd, 2005). Classic social psychological investigations of social influence and persuasion have show that there is a fair amount of consistency in the social conditions that result in individuals and groups remembering some things and forgetting others, or adopting some norms and attitudes and eschewing others (Asch, 1951; Hovland, Janis, & Kelley, 1953; Sherif & Murphy, 1936). As we'll argue later, it is likely that the "decisions" which this involves also rely on evolved psychological mechanisms that increase the likelihood of individuals ending up with the optimum arrangement of beliefs and behaviors that their culture has to offer.

## Biological and cultural evolution

The molecular mechanics of the biological inheritance system are now well understood and the idea that a physical substance (DNA) carries inherited information has become part of mass culture. Richard Dawkins (1976) proposed a Darwinian analysis of cultural change in which "memes" are analogous to genes. Dawkins envisaged memes to be discrete replicators that spread through a population and which can be worked on by natural selection. One problem of this way of thinking about cultural evolution is the variableness of cultural variants. Some are discrete units of information (such as the fact that chili peppers are safe to eat despite their sensory effects) but others (such as beliefs about what constitutes appropriate work for a lady) are more complex and perhaps cannot be faithfully transferred from mind to mind (Sperber, 1996: Chapter 5).

We cannot, at least not yet, define the nature of a "meme" or even know if it is useful to think of culture as a collection of units but this lack of understanding does not prevent a Darwinian analysis of cultural change. Many schemes for transmitting heritable variation are susceptible to a broadly Darwinian analysis (Richerson & Boyd, 2005: 80-94). Remember that Darwin laid the foundations of evolutionary analysis with no knowledge of genes, what they do, or how they mutate. For the evolution of an information system to be analyzed, only two criteria need be met: (1) the system must contain characteristics that can be passed on (i.e. inherited) and (2) these characteristics must vary between individuals in a population. Darwin recognized that variants continue in a population as long as they continue to be inherited and that the probability of their recurrence in the next generation can be affected by a number of forces. Exactly the same can be said about the information, technology, beliefs, ideas, preferences, habits, expertise and all the other potentially variable elements that make up culture. The key to evolutionary analysis is identifying and investigating the forces that affect the continuity of cultural characteristics and the emergence of new ones.

The variability of cultural elements is undoubtedly shaped to some extent by preferences laid down by human genetic inheritance (Barkow, Cosmides, & Tooby, 1992; Daly & Wilson, 1983; Durham, 1991) but when it comes to deciding how to behave, culture routinely overwhelms biology. For example, military training (Richerson & Boyd, 1999) and religious indoctrination (Wilson, 2002) often lead people to perform feats of altruism on behalf of their community, fellow believers, or a whole nation without in anyway benefiting their "selfish genes". More prosaically, individuals are routinely persuaded to endure pain in order to behave according culture's norms. For example, many western women feel compelled to dance while wearing five-centimeter stiletto heels. Given the permanent problems with the feet and back that this has been observed to cause (Rudicel, 1994) the wearing of currently fashionable female footwear bears a disturbing similarity to the foot-binding practices in 19$^{th}$ century China (Brown, 2004). The need to avoid causing more immediate or severe damage does seem to set limits on cultural evolution, however. Actual amputation of healthy feet and a preference for hand walking are unlikely to become cultural norms.

The constraints that the human genetic endowment places on cultural evolution have to be seen in the context of the effect that culture has had on the composition of that endowment. The practices and preferences that a population acquires through cultural evolution also affect the selection of genes, such as when a cultural preference for certain physical characteristics makes it more likely that an individual with these traits is chosen as a sexual partner or less likely that she is chosen as a victim of infanticide.

Gene selection can also occur as a result of two less direct mechanisms. First, the adoption of a cultural practice can result in some individuals thriving at the expense of others. For example, populations that learned how to extract a nutritious food source (milk) from domesticated grazing animals were better equipped to exploit the grassland habitat, but not all members of the population would have benefited equally. Those lucky enough to have a genetic makeup that enabled them to continue drinking milk beyond the age of weaning were better able to tolerate the new food. After a number of generations, the migration or poor survival of individuals who could not produce the enzyme that breaks down the milk sugar (lactose) would have made the

genotype that confers lactose tolerance virtually universal in populations for which milk is an important component of the diet (Simoons, 1969, 1970). Second, the practices of a population may alter the environment in such a way that the selective pressures on the population are changed. An example of this is the increase in the incidence of the sickle cell genes in West African populations that began to cultivate yams (Durham, 1991). The growing of yams required the cutting of clearings in the rainforest. This increased the amount of standing water, which in turn increased the prevalence of malaria-carrying mosquitoes. And this, in turn, increased the relative chances of survival of individuals who were protected from malaria because they carried a sickle cell gene.

The preferences and practices inherited culturally can also shield transmitted characteristics from the action of natural selection (Laland, Richerson, & Boyd, 1996). For example, if the range of a species of animal widens to include regions with colder climates, those individuals whose physiology and anatomy make them better able to withstand the cold have a selective advantage. In the case of humans, individuals with a round, high surface-to-volume ratio body shape, would require less energy to remain warm than individuals who are tall and thin. However, clothing, fire, and other culturally evolved methods of protecting against the cold reduce the selective pressure exerted by nature and allow a population to maintain a wider variety of body shapes or evolve toward body shape that meets a *culturally* evolved preference rather than one that is environmentally expedient. Culture enables groups of humans to create (and constantly recreate) the ecological niche they inhabit (Odling-Smee, Laland, & Feldman, 2003). Inevitably, as in all ecological niches, the composition of the gene pool changes as some individuals achieve greater reproductive success. These genetic changes can then influence the course of cultural evolution.

The coevolution of genes and culture creates opportunities for behaviors to evolve that could not have evolved through the action of natural selection on genes alone. Modern human behavior is the product of many hundreds of generations of interplay between the genetic and cultural inheritance systems. In chimpanzee groups, powerful successful alpha males usually mate with all the females in their group as they become fertile and are aggressive to rival males. Stronger males therefore have more offspring than weaker ones and their male offspring are likely to inherit, not only the father's strength, but genes that promote taking advantage of strength. The evolution of a group of primates with the capacity for culture (such as our early hominid ancestors) can go in a quite different direction. The females of such a group might *culturally* evolve a preference for males who are not promiscuous, who help provision their offspring and who are reluctant to fight. In this *cultural* environment, females may still prefer large strong capable males but they especially favor those with genes that endow them with a tendency to suppress sexual and competitive aggression in order to devote effort to productive activities.

Biological evolution can explain altruism between kin and individuals who can develop a long history of reciprocal mutual aid, but the extensive cooperation between non-relatives seen in humans is a puzzle from the point of view of standard evolutionary theory. Gene-culture coevolution provides an explanation for the evolution of behaviors that allow humans to create cooperative social groupings of non-relatives (Richerson, Boyd, & Henrich, 2003), but it is not the only explanation

entertained by evolutionists (Henrich et al., 2003). Groups which interact infrequently can evolve very different cultural traditions and institutions. The ones with cultures which enable or encourage their members to behave more effectively will thrive at the expense of groups which are less culturally well endowed. Cultural evolution is, therefore, more susceptible to group selection than is genetic variation. Groups which developed traditions of punishing selfish behavior detrimental to the group as a whole may well have been more successful than groups which tolerated more individualistic behavior. Genes which facilitate cooperation could have arisen in such groups because the cultural environment would have favored individuals who were more docile and willing to behave in accordance with cultural norms. Repeated coevolutionary cycles could eventually drastically modify the psychological mechanisms that influence human social interaction.

Note that sharing knowledge with others is potentially a form of altruism and also, potentially, a means of exploiting others by propagating self-serving ideas. Language vastly expanded our capacity to transmit both useful and deceptive information to others (Knight, Studdert-Kennedy, & Hurford, 2000). Complex culture can arise only if members of a group socialize their youngsters to be informed and "properly behaved" fellow members of their cultural group and it can only be maintained if a large enough group of individuals continues to hold, share and pass on the information possessed by the group. The number of people needed to support cultures of hunter-gatherers is surprisingly large, as Henrich (2004) shows in his comparison of the technological complexity of a number of hunter-gatherer cultures. When Europeans first encountered the aborigines inhabiting Tasmania, their population of 4000 had a very limited toolkit compared to that of mainland aborigines. Archeological investigation has revealed that, during the 10 to 12,000 years since rising sea levels had caused Tasmania to be cut off from the mainland, the isolated islanders had gradually lost many skills, including fishing and the making of clothes, their ancestors had possessed.

The diversity of languages and other symbolic elements of culture is interesting in this light because divergence of language essentially socially isolates groups. Why did a characteristic evolve that places constraints the complexity of culture? In small-scale societies, the people who are subject to the same norms of cooperation also speak the same language or dialect. Did rapid change in language become established because the resulting dialect variation serves to protect the members of a cultural group from members of groups with which they no longer regularly communicate? When groups can no longer effectively communicate, members are less likely to inadvertently betray their own group's cultural secrets to competing groups and they are also unlikely to be manipulated by malign advice or comment from competitors. In modern contexts, linguistic variation grows rapidly along social fault lines, generating new linguistic diversity and perhaps protecting and generating other forms of cultural diversity (Labov, 2001). Contrariwise, the establishment of standard forms of speech via education and mass media is arguably responsible for the emergence of national sentiments and the destruction of much small-scale cultural variation in the large societies of the modern period (Anderson, 1991). Most likely, the social psychology that we deploy in deciding whom to trust for purposes of imitation and teaching has innate elements that were built by gene-culture coevolution.

That humans are highly cooperative animals is supported both by common experience and experimental evidence. People may complain about the selfishness and dishonesty they encounter but the fact such behavior is considered worthy of complaint is telling. Our societies only function because there is a general level of trust, an expectation that we will be trusted, and a willingness to identify and punish individuals who behave in an untrustworthy way. To investigate the nature of human cooperativeness, economists have developed games for people to play in the laboratory that give subjects the opportunity to behave selfishly or cooperatively in an environment in which social cues that encourage cooperation can be controlled.

One of these games, "Ultimatum", is played between two players who are never known to each other. One player is randomly selected to be the "proposer" with the task of proposing how a sum of money will be divided. The other, the "responder" can accept this division or reject it. If the proposal is rejected, neither gets any money. This game played between selfish rationalists would result in the proposer getting the maximum share possible and the responder accepting whatever remains; even a 99 to one split would be accepted by a selfish rationalist since anything is better than nothing. The overwhelming conclusion of these studies, when they are carried out in western populations, is that humans do not behave like selfish rationalists. Most proposers share the money 50-50 and many responders reject offers smaller than 25-30% of the proposer's windfall.

In a series of studies that exemplify current quantitative cross-cultural research, Joe Henrich and his collaborators (Henrich et al., 2004) took the Ultimatum game to 15 cultures with varying degrees of integration with the global economic system. They found that the more contact and integration the groups had with modern market economies, the more likely their members were to choose a 50-50 distribution. The more isolated the culture, the more likely their members were to propose and accept offers which those in market economies find unfair or bizarre. The family-based Machiguengan culture of southeastern Peru both propose and accept very low offers and members of the Gnau and Au culture of Papua New Guinea make offers of a larger then fifty per cent share. (The larger offers were likely to be refused because, in this culture, accepting such offers would make the responder uncomfortably indebted to the proposer.) The 50-50 split commonly agreed by members of market economies perhaps reflects a greater exposure to the cultural tradition of fair dealing with strangers that allows modern markets to operate. Even if a concept of how to deal with strangers is partly a cultural construct, however, in none of the cultures did players behave like selfish rationalists. Hence the conclusion that humans possess a genetically evolved tendency to behave cooperatively. The innate tendencies are reinforced, however, by culturally evolved practices which promote cooperation and trust.

Human social instincts also include what could be thought of as cultural tools, such as the capacity to rapidly acquire a sophisticated symbolic system of exchanging information (language), a tendency to categorize human groups on the basis of appearance or dialect or symbolic markers such as dress (Gil-White, 2001; Richerson & Boyd, 2001) and a set of preferences or biases that influence which cultural variants an individual chooses to acquire (Richerson & Boyd, 2005). These preferences serve as a quick means of choosing which cultural variants to acquire. Such short cuts are necessary because, as cultures accumulate values, skills,

knowledge etcetera, its members have an increasingly wide choice of variants to adopt. This makes it increasingly difficult and eventually impossible for members to even be aware of every cultural variant available. If humans spent a large proportion of their time investigating the value of each variant, culture would cease to be effective as a way of enabling individuals to gain expertise rapidly. Individuals who made reasonably good decisions quickly would have been more successful than those who made bad decisions and also more successful those who made good decisions but only after much deliberation (Gigerenzer & Goldstein, 1996). The ability make sensible judgments quickly would have been reflected in the number of children an individual produced; so natural selection would have favored individuals with innate preferences that made such behavior most likely.

One obvious rule-of-thumb to follow when deciding whether or not to replace a cultural variant would be to avoid replacing a familiar belief or behavior with a new one unless there is a good reason to do so. There are also often practical reasons for maintaining the status quo. Standardizing driving practices worldwide so that everyone drives on the left-hand side of the road may bring long-term benefits but the short-term expense and chaos it would bring has caused few countries to even contemplate it. In many domains, however, humans readily investigate novel cultural variants. Judging by the alacrity with which people embrace unfamiliar foods, be it "ethnic cuisine" or Western "fast food", we are relatively unconservative in our taste in food. Historical inertia is profoundly important in characterizing a culture but individuals who fear novelty and doggedly follow old ways would have been at a disadvantage compared to those willing to consider promising innovations.

One reason for suspecting that a new cultural variant is worthwhile is that other people have adopted it. The social provenance of a variant is usually easier to establish than its actual worth and it is reasonable to assume that at least some of the individuals who adopted the variant would have taken trouble to evaluate its worth. A good rule-of-thumb to follow when contemplating what cultural variants to adopt is to imitate behaviors that are popular with people who are similar to oneself, who seem confident in what they are doing or who are considered worthy of admiration (Boyd & Richerson, 1985; Henrich & Gil-White, 2001). Research generally supports the existence of such preferences in people's conformity to social norms (Asch, 1956; Sherif & Murphy, 1936) and adopting attitudes (Chaiken, 1979; Simons, Berkowitz, & Moyer, 1970; Wright, 1966).

The transmission of cultural information depends on which cultural variants individuals acquire so, at the population level, these preferences can be seen as "forces" that influence the direction of cultural evolution. The magnitude and interaction of a number of forces affect the ways that cultures change.

## The processes of cultural evolution

Any particular bit of cultural variation is likely to be subject to a complex of processes, some tending to increase its future representation in the culture, some tending to decrease it. It is impossible to predict precisely how a culture is likely to change because of the complex concatenation of forces that influences this change. This does not mean, however, that cultural change is unfathomable; it is complex but

not random. The evolutionary analysis of cultural evolution follows the same pattern as genetic evolution although the details are considerably different.

First of all, consider the inheritance system. In the *genetic* inheritance system, the information, coded in genes, is transmitted from parents to offspring with considerable fidelity. The transmission process itself merely recreates the population from generation to generation with no change in the frequencies of genes. The cultural inheritance system is not nearly so rigid. Transmission of cultural information can be from parents to offspring, from other adults to children, or among people of similar age and experience. Cavalli-Sforza and Feldman (1981), following the terminology used by epidemiologists, termed these three prototypical types of transmission, *vertical*, *oblique*, and *horizontal* transmission respectively. To the extent that such patterns of transmission operate by faithful teaching or imitation, the looser structure of cultural transmission still acts to replicate the *status quo*. As in the genetic inheritance system, the transmission process itself does not affect the frequency of cultural variants. Whether a cultural variant is transmitted vertically, horizontally or obliquely, it is still passed on.

Evolution occurs in both the genetic and cultural inheritance system because of forces that cause the frequency of variants in the population to change. Some of the forces are the same in both in both systems so it is worthwhile to look for a moment at the simpler genetic evolutionary process.

The extent to which a *gene* is present in the next generation depends on four forces:

- Natural selection – The genes of individuals who are more efficient converters of environmental resources to offspring will be more highly represented in the offspring generation.
- Mutation – Copying errors and damage to genes will cause random changes to individual genes, slightly reducing the level of parental genes and generally increasing genetic diversity.
- Drift – All populations are finite so there will never be a perfectly probabilistic distribution of parental genes for reasons that have nothing to do with their effects on the organisms that possess them.
- Migration – Flows of genes between sub-populations who might be adapted to slightly different environmental conditions reduce the effect of natural selection and drift.

The basic task for cultural evolutionists is the same as that of evolutionary biologists: to identify and investigate the forces that affect the transmission of characteristics in a population (in this case the *cultural* characteristics) using mathematical models and empirical investigation. The purpose of the models is not to produce precise descriptions or predictions of cultural change but to investigate the operation of forces at the population level. They are useful in the same way as meteorological models are useful for forecasting (but not precisely predicting) future weather. The systems that affect weather are so complex that even vastly complex models cannot predict the detail of weather and climate change. However, relatively simple models provide useful broad-brush explanations and forecasts, which improve as our understanding of meteorological processes increases.

First of all, changes in the frequency of cultural variants that occur over time is influenced by the same four forces mentioned above identified as influencing the remolding of the combination of genetic variants that exist in a population:

- Natural selection – the prevalence of variants will decline if they are possessed by people who have fewer offspring.
- Mutation – random changes in cultural variants occur when learners do not reproduce them accurately.
- Drift – the flow and transmission of cultural information cannot be completely uniform throughout a population so inevitably there are random differences in the cultural variants that groups are exposed to. Groups within a culture whose members have little contact with one another will increasingly diverge.
- Migration – brings new variants to a population and this results in decreased prevalence of the old ones.

The evolution of culture differs from the evolution of genes most strikingly in being subject to what we call "decision-making forces". Because cultural transmission is spread out over a significant fraction of our lives, the cultural variants we adopt are influenced by the behavioral choices of the individuals taking part in our social interactions. We make choices (consciously or unconsciously) about what we say or display to the people we interact with and this affects which of our behaviors and beliefs they are exposed to. Once a cultural variant has been displayed, its transmission then depends on the choice made (consciously or unconsciously) by each observer. Will he adopt it, ignore it, dismiss it, reject it, not notice it or forget it? Evolved cultural acquisition tools create innate preferences or "biases" which incline a person to adopt some variants rather than others. These biases, operating in each individual member of a culture, sort among existing cultural variants, causing some to increase in frequency and others to decrease. Donald Campbell (1965) called biases "vicarious selectors" because he imagined that the biases themselves ultimately arise from the action of natural selection on the genetic and cultural features of the biases. Vicarious selectors evolve because being natural selected is a costly business and behavioral mechanisms to anticipate and forestall it will be favored. However the higher order effects vary depending on the type of bias.

Innate cultural acquisition tools are undoubtedly shaped and sharpened by learning, both individual and social learning. For example, once a child reaches adolescence she may begin to imitate her parents less and abandon some vertically acquired cultural variants in favor of those of her peers or teachers. This change may occur because her culture expects adolescents to begin to ignore parental influence but the adolescent may also have had personal experiences that lead her to realize that her parents' judgments are often not reliable in some areas. And there might also be an innate component to teenage rebellion. In ancestral populations, children who began to question parental authority once they approached sexual maturity may have had greater reproductive success than those who maintained childish compliance. Any genes that encouraged "teenage rebellion" behavior would then have been genetically selected.

Establishing the factors that influence the adoption and development of social norms by individuals and by groups has been the aim of much very fruitful research in social psychology. Although most social psychologists have not approached the study from an evolutionary perspective, their findings are consistent with the operation of psychological mechanisms that evolved because they encouraged quick and reasonably effective decisions on which cultural variants to acquire (Gigerenzer & Goldstein, 1996). For example, the "Elaboration Likelihood Model" of (Petty & Cacioppo, 1986) describes two routes by which exposure to a message leads (or fails to lead) to a change in attitude. In taking what they call the "central route to attitude change" an individual decides to take up a new cultural variant by considering the content of a persuasive message. However, the "peripheral route to attitude change" provides an alternative decision-making mechanism for those who are unable or lack the motivation to elaborate on the content of the message. Instead, a quick assessment of peripheral cues (e.g. pleasant images or emotions or indicators of expertise) that are associated with the source of the message and its delivery provides the basis of evaluation. Attitudes formed by the peripheral route are, however, less stable and less likely to predict behavior than those formed by the central route.

Boyd and Richerson (1985) considered three "learning biases" that arise from the way individuals decide which cultural variants to adopt.

- Content-based bias – Individuals choose to adopt a cultural variant based on consideration of the variant itself. Essentially they are taking the "central route" (Petty & Cacioppo, 1986) to choosing a cultural variant. Some variants are clearly useful or superior to the alternatives. When the best choice is not so obvious, learners can weigh up costs and benefits or determine how consistent a new variant is with those that have already been adopted.
- Model-based bias – Individuals can choose to adopt a cultural variants based on considering the social provenance of the variant. In many cases it, it may be more expedient for a learner to avoid the trouble of weighing up whether a cultural variant is worth adopting and simply look at who else has adopted it and whether they are worthy of imitation. Are they happy, confident and successful in terms the learner identifies with? The literature on persuasion provides ample evidence that such considerations are very influential in individuals' decisions (e.g. Perloff, 1993). Prestige systems are usually based on symbols with which members of a culture identify. People in a given culture or sub-culture share a common definition of prestige and the behavior that defines prestige. For example, some English speakers may (consciously or unconsciously) attach more significant to information delivered with a "posh" accent, while others favor other accents.
- Frequency-based bias – Individuals can choose to adopt a cultural variant based on considering how popular it is. Variants that are very common are likely to have been adopted and kept for good reason (Henrich & Boyd, 1998). Individuals with a tendency to copy the most popular behavior are therefore likely to benefit from the experience of their fellow group members. In many cases, conforming also prevents a naïve individual inadvertently breaking some implicit rule of cooperation and risking punishment by fellow group members. Even if the practical benefits of a variant may be limited, there are social benefits associated with sharing the

attitudes of other members of one's social network. If all of your friends have taken the trouble to learn the goal scoring record of every member of the Premier League, it is a good idea to learn them too or you might have nothing to talk with them about in the pub on Friday nights. The classic social psychological experiments of Asch, Sherif and others established the human tendency to adjust their behaviors to that of the people around them and demonstrated the persistence of behaviors and beliefs thus acquired (Asch, 1956; Festinger et al., 1950; T.M. Newcomb, 1943; T. M. Newcomb et al., 1967; Sherif & Murphy, 1936). More recent research has attempted to characterize the group processes that contribute to the formation and change of social norms (Moreland, Levine, & McMinn, 2001; Postmes, Haslam, & Swaab, 2005).

A learner can only adopt the cultural variants that are actually on display so cultural transmission is also subject to "communicator biases". Individuals can choose when and to whom they will display or communicate the variants in their cultural repertoire.

- Situation-based bias – A tendency to conform to group norms will limit the behaviors a person displays based on whom is observing and the social situation they are in. This will reinforce the conformist bias on the part of the observers. Research in stereotyping has shown that cultural traditions influence how members of a culture behave in front of members of other cultures and also specific groups within their own culture based on sex, age and occupation (Allport, 1954).
- Observer-based bias – There is evidence that evolved mechanisms influence contributions to a conversation. When asked what reproductive advice would be appropriate in a range of situations, mothers were more inclined to encourage behavior consistent with reproductive success if they are primed to think in terms of advice being given to a daughter than to a friend ( Newson, 2003; Newson, Postmes, Lea, & Webley, 2005). There may also be innate tendencies that influence how an individual behaves in front of a group vs. an individual or with close friends vs. strangers.

Human beings, acting as individuals or in groups actively attempt to direct or influence cultural change. This introduces two more forces.

- Innovation - Individuals occasionally invent a new cultural variant or (more often) modify an existing one rather than faithfully copying one of the already existing cultural variants. The deliberate engineering of more appropriate genes has only begun to be a factor in biological evolution but adjusting and improving cultural variants is an important force in cultural evolution. Individuals can mix social and individual learning in a way that is reminiscent of Lamarck's (and Darwin's) ideas about organic inheritance (Boyd & Richerson, 1989). Innovation usually takes more effort and is more risky than adopting cultural variants used by others so it is more likely to occur when existing variants are inefficient. Perhaps existing variants are difficult to understand or imitate correctly. Changes in the physical or cultural environment may have made them less appropriate. It is in the interest of societies to encourage innovation because, when new variants are more effective, they can then be copied by others and potentially the whole society benefits. Populations are likely to be more successful if they evolve

institutions that reward scholars and inventors when they are successful and nurture those that show promise. A society that rewards its merely technically competent physicians more richly and more consistently than its creative and talented biomedical and social researchers is likely to evolve an increasingly costly, cumbersome and inefficient health system.

- Group decision-making – Conformity and group processes create the tendency for individuals within a network to agree on the cultural variants to adopt but when the interests of group members diverge, culturally evolved institutions for collective decision-making may be employed (Boehm, 1996). The procedures used by these more formal decision-making methods will also influence cultural change. For example decisions made through a referendum process are likely to differ from those made by committees of appointed experts. The extent to which a population employs formal decision-making processes is, therefore, also likely to affect the way a culture changes.

In summary then, cultural evolution is influenced by the same five factors that influence biological evolution:

- The vertical transmission of variants (from parent to child)
- Natural selection
- Mutation
- Drift
- Migration

Added to this is the effect of the pattern of cultural variant transmission, which is more complex that the transmission of genetic information. Cultural variants can be transmitted:

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- Between peers (horizontal transmission)
- From older/more experienced non-parents to younger/less experienced individuals (oblique transmission)

Because of the greater complexity of cultural transmission, additional forces influence changes in frequency of cultural variants in a population:

- Bias on the part of the person acquiring the cultural information (learning biases):
    - Content-based bias (based on an evaluation of the variant itself);
    - Model-based bias (based on an evaluation of the prestige or success of the source of the variant);
    - Frequency-based bias (based on an evaluation of the popularity of the variant).
- Bias on the part of the person displaying or communicating the cultural information (communicator biases):

    - Situation-based bias (based on the communication's evaluation of the social situation);
    - Observer-based bias (based on the communicator's evaluation of the observers present).
- Explicit attempts by members of a culture to influence cultural change.
    - Innovation – the invention of a new cultural variant that may potentially replace older ones.
    - Group decision-making processes – their nature and extent.

This concatenation of forces averaged over a population drives the cultural change which the population experiences. By analyzing cultural change in terms of these forces, it is possible to broadly explain patterns of historical cultural change and make testable predictions about changes in characteristics of cultures such as patterns of diversity.

## The dynamics of cultural diversity

Just as some genes are not passed on and disappear during the course of biological evolution, some cultural variants are ignored and eventually forgotten as culture evolves. However, new cultural variants are also constantly being created. Among the cultural evolutionary forces mentioned above, some act to generate cultural variants while others cause variants to become extinct by selecting some at the expense of others. There are also forces that have no effect on the total number of variants but do influence the way they are distributed. If cultural diversity is defined as the number of cultural variants available to members of a population, changes in diversity can be analyzed by looking at the balance between the forces that generate new cultural variants and those that select between them. If cultural diversity is defined as the extent of cultural difference between groups or regions, it can be analyzed by looking at the balance between forces that disperse variants and those which create barriers to their dispersal.

Looking at the processes of cultural evolution one by one:

- Natural selection – Any force which selects between variants reduces diversity. Selection normally acts to constrain variation within a culture. Many variants are passed from parents to offspring so those which are associated with individuals who fail to thrive and produce offspring have a tendency to become less common in a population. An extreme example would be the values and beliefs of cults which demand that their members practice mass suicide or strict celibacy. Cultural variants associated with such groups are less likely to be passed on to future generations. An exception occurs when frequency dependent selection favors rare types. As labor becomes increasingly divided in a society, for example, natural selection disfavors skills that are too common with respect to economic demand and favors scarcer skills. Complex societies have evolved an ever-increasing division of labor and a good deal of within-culture diversity is the result of division of labor. Inter-society trade is important in most human

societies leading to some division of labor between societies. If all else is equal, inter-society division of labor will reduce diversity within societies and increase it between societies.

Trade aside, selection has complex effects on inter-societal cultural diversity. Much between-societies cultural diversity is due to cultures adapting to local conditions. By the late Pleistocene, anatomically modern hunter-gatherers had spread to virtually all the world's habitable landmasses, developing a considerable diversity of subsistence strategies (Klein, 1999). Adaptive divergence is limited to the extent that societies in similar environments acquire similar adaptations (Johnson & Earle, 2000). But adaptive convergence is never complete, in part because environments are never exactly alike (Diamond, 1997) and probably in part because, like other complex design problems, the same functions can be realized more or less equally well by rather different arrangements (Boyd & Richerson, 1992a). Modern developed nations are a case in point. Despite much convergence, the G-8 nations retain many distinctive differences in every aspect of their societies.

- Mutation – Random copying errors are the ultimate source of variation in genetic systems and random errors in cultural transmission play a similar role. Random errors will tend to increase diversity both within and between cultures. However, as Henrich (2004) has shown, the errors that occur in cultural transmission also limit the diversity of culture by limiting the complexity of cultural traits. Complex multi-component cultural traits are more likely to be transmitted with fatal errors. Small populations are more likely to lack the rare highly skilled individuals who can recognize and repair mistakes that develop as complex techniques are passed on so, as mentioned earlier, the internal complexity of the culture that a population can sustain is limited by its size. Henrich reviews evidence that sophisticated watercraft was lost not only on Tasmania but also on other small islands in Oceania despite their importance to subsistence on islands that retained them. Under these assumptions, errors will cause similar losses in different small-scale societies, reducing the scope for between-group as well as within-group diversity. Techniques for storing cultural information outside the human mind, such as in texts or pictures can counteract this effect allowing small communities, such as a scientific sub-discipline, to maintain a large store of complex knowledge (Barth, 1990; Donald, 1991).
- Drift – When cultural variants are rare or seldom used in a population, there is a random chance that they will be forgotten, creating the cultural analogue of genetic drift. Drift, therefore, is a force that decreases the total number of cultural variants. Since the effects of drift are random, and affect different cultures independently, diversity between cultures is increased by drift. Again, techniques for creating external stores for cultural information counters the effect.
- Migration – Spatial and social mobility causes people who have adopted different cultural variants to interact. This increases cultural diversity on the local level because a mixing of culturally different people increases the number of variants to which individuals in each group can be exposed but it

has no affect on the overall number of cultural variants that exist. The cultural diversity between groups is reduced by migration.

Conquest is a special case of migration; the military or commercial conquest of culturally different populations, often leads to considerable reductions in diversity. This is well documented in the case of languages (Nettle, 1999). For example, the European conquest of the Americas led to the loss of most Amerindian languages to Spanish and English. Foster's (1960) study of the spread of other elements of Spanish culture to Latin America is a classic. A rather limited subset of Spanish culture penetrated to the New World giving Latin America anomalously low cultural diversity along many dimensions besides language. The ethnographic record suggests that such conquests are an ancient factor in patterns of diversity (R. C. Kelly, 1985; Knauft, 1985). In the contemporary world, global mass communication makes European and especially American culture known to practically everyone.

- Bias on the part of the person acquiring the cultural information (learning biases) – These are selective forces; individuals choosing to adopt only some cultural variants while ignoring or abandoning others generally brings an overall decrease in the diversity of cultural variants.

  - Content-based bias – This is highly analogous to natural selection. If a new cultural variant is widely perceived to bring practical benefits, it will be widely adopted, thus decreasing cultural diversity. An example of this is the widespread adoption in Europe of the potato as a staple crop during the $17^{th}$ and $18^{th}$ century. In many farming areas, choosing to plant potatoes over other crops increased the amount of food a peasant family could produce and the number of children it could successfully raise. In the case of the potato, the benefits were found to be exaggerated and the farmers' dependence on the crop resulted in widespread famine when potato blight decimated crops in the $19^{th}$ century. Nevertheless, the cultivation of the new crop had contributed to a rapid population expansion that prompted the migration of Europeans to other continents.

    The diversity-reducing effect of content-based bias will be mitigated by individual or group differences, both learned and genetic. If some groups of Europeans had been genetically ill-equipped to digest potatoes, they would have not adopted the crop. Most human populations outside of the traditional dairying populations of western Eurasia and Africa cannot digest milk sugar (Durham, 1991). Thus in eastern Eurasia an alternate technology based upon soybean products evolved to fill roughly the same nutritional niche as milk. Much cultural diversity exists because literal and figurative tastes differ. Adaptive diversification and convergence will proceed in roughly the same way as it does with natural selection.

  - Model-based biases – The imitation of individuals deemed by a group or subculture to be good models has the effect of decreasing diversity within that group while increasing diversity between groups that have different criteria for choosing good models. The effect is, therefore, like that of conformity bias.

Symbolic systems are a very rich source of between group diversity because of the arbitrary nature of symbols. High status can be symbolized by elaborate tattoos, as in Polynesia, or by "designer clothes", as in today's global commercial culture. Linguistic diversity is the most striking example.

- Frequency-based bias – Conforming to cultural norms by adopting cultural variants most common in the cultural or sub-cultural group decreases diversity within groups and helps to maintain diversity between groups when migration occurs because migrants will begin adopt the variants most common in the population they have joined.

- Communicator biases – Individuals choosing under which circumstances to display a cultural variant limits the number of cultural variants available for adoption. The effect varies, however, depending on the type of bias.

  - Situation-based bias – Potential cultural models regulating their behavior depending on the social situation tends to reinforce ritual behavior, decreasing diversity within each social situation but emphasizing differences between them. For example, "office worker behavior" may be similar in many different business organizations and be quite different from the "factory worker behavior" seen in another part of the same organization. In both cases, the behavior displayed is likely to change substantially when individuals leave work to be with their families or take part in leisure activities. The long-term population level effects of this have not been the subject of systematic investigation.

  - Observer-based bias – Potential cultural models regulating their behavior depending on who is watching is a barrier to the transmission of cultural variants and will tend to decrease diversity within groups. For example, children will mostly see adults displaying cultural variants which adults deem appropriate for them to see. However, it will also tend to increase diversity between groups. Children will behave differently from adults, at least while adults are present. Again, the long-term population level effects of the tendency of individuals to regulate their behavior in response to the observers present has not yet been subject to systematic investigation, however, so it is only possible to speculate on how this force may influence cultural evolution.

- Innovation – The invention of new cultural variants is a force that increases diversity. When new variants are clearly superior to older variants, they may replace them but often inventions increase choice and cultural complexity. For example, the invention of the automobile replaced bicycles and horses for many purposes but the riding of bicycles and horses is still part of modern culture.

- Formal group decision-making processes – When a group decision-making process is well supported by the group, it has the power to limit cultural diversity within the group and increase it between groups. Members will cease to have the choice whether or not to adopt a cultural variant. For example, if a decision to ban pornography is made and effectively enforced, the use of pornography cannot be adopted by group members. However, a group-decision making process is unlikely to maintain the support of the

group if its decisions are unpopular with members or if the decision put the group at a disadvantage compared to other groups. Subcultures can often persist and even thrive in the face of considerable repression. For example, Handelman (1995) describes how the Russian Thieves World organized crime community persisted in the face of Imperial and Soviet repression. One might have thought that authoritarian societies that invest much in police "services" and that have heavy punishment for deviance might at least be free of organized crime. However, the Thieves World rather successfully resisted suppression, much as the ethnically based prison and youth gangs thrive in the US despite (or perhaps because of) long prison terms.

It may be the case that groups which use similar group decision-making processes tend to make similar decisions. It is commonly alleged by some politicians, for example, that democracies are less likely to declare war. If this were the case, then finding effective means of group decision-making would have the effect of reducing cultural diversity between groups. Certain group decisions may support diversity. The most obvious would be decisions that specifically protect minority cultures. The US Bill of Rights protects religion and speech, ensuring protections for many kinds of cultural variation. Swiss federalism provides for canton-level autonomy in many matters. Many group decisions will have complex effects upon cultural diversity. Economic growth policies will tend to bring modernity's effects on diversity, reductions of local diversity in many aspects of culture while increasing the diversity of occupations and spawning many medium-size sub-groups such as businesses and government bureaucracies.

## Reprise: Effects of Modernization

Modern communication and transportation technologies and the development of global markets have profoundly changed the social environments in which culture is propagated (Inkeles, 1983). By examining how these changes affect the balance of cultural evolutionary forces, we can estimate how these changes will affect cultural diversity (Henrich et al., 2001; Shoumatoff, 2005).

In theory, modern communication could allow social influence to be centralized and the dissemination of cultural ideas to be dominated by a small number of powerful individuals or groups who could decide to suppress the dissemination of some cultural variants while attractively presenting others. Even if such individuals had no malign intentions, their activities could, in theory, destroy diversity and create a homogenized global culture.

This is unlikely to be the case in practice, however, because whether a cultural variant is adopted or ignored depends on the decision-making processes in the minds of potential recipients of the information. Evidence suggests that increasing the means by which the information can be transmitted has little effect on these processes. For example, the wide-scale acquisition of mobile phone use behavior, which brought substantial changes to the lives of many people, did not occur immediately as a result of exposure to advertising and news of the new technology. The pattern of adoption traced the same S-shaped curve (Massini, 2004) as the adoption of hybrid corn among Mid-western farmers in the 1940's (Griliches, 1957), suggesting that the spread of mobile phone use largely took place by diffusion as non-users modeled their behavior

on those who had adopted the new technology. Their decisions were the result of some combination of model-based and frequency-based bias cultural transmission. Content-based bias undoubtedly also played a role. The rate of adoption was slightly influenced by variations in the cost of buying and using mobile phones, suggesting that at least some people partly based their decision on an analysis of costs and benefits. Henrich (2001) has found that biased cultural transmission dominates in practically all cases of the diffusion of innovations.

Mass communication, therefore, may well hasten the spread of a useful new cultural variant at the *population* level because it makes it possible to expose many people to the new cultural variant simultaneously, but *individuals* still go through the same process when deciding whether to adopt a new variant. This is substantially based upon observations of earlier adopters.

New technologies which threaten to reduce cultural variation may also provide means of preserving or increasing it. For example, random errors in the transmission of cultural information (mutation) is a source of cultural variation which is potentially much reduced by computers, photocopiers, printers and the equipment for recording and copying audio and video. Centrally planned educational syllabuses, textbooks and standard exams attempt to ensure all students in a population are exposed to more or less the same things in the same way. What consumers of information actually *learn*, however, cannot be controlled and it may be that information reproduction technology actually *increases* the likelihood of errors in the transmission of cultural information. Cultural transmission occurs when a cultural variant is reproduced in a *human mind*, not on paper or disk. Simply presenting many people with many identical copies of accurately stored information does not ensure error-free transmission of the same cultural variant to every one of them. It fact, it increases vastly the amount of information to which people can be exposed. Potential learners can choose where to direct their attention.

While not decreasing the net amount of cultural variation, changes in social interaction can reduce diversity between groups and regions. This shift began with the development of agriculture. Pagel and Mace (2004) have suggested that human subpopulations continually secede and diverge from larger groups to better control some defensible resources. In a simple society of nomadic foragers, cultural divisions create geographical separation because the physical environment is the source of the resources. The more resource-rich the physical environment therefore, the larger the number of cultures it can support. The development of technologies which increase the resources that can be extracted from the environment inevitably allow a greater diversity of cultures to occupy a given area. The development of agriculture increased the carrying capacity of some habitats enough to allow the growth of population centers of unprecedented size and density. This brought changes in the pattern of cultural diversity with different cultures and subcultures inhabiting the same geographical space.

Some diversity of social roles does exist within mobile foraging cultures, primarily based on age and gender (R. L. Kelly, 1995), but all members of a cultural group exploit the same habitat or habitats so they must all acquire more or less the same knowledge and skills. In sedentary societies, members have more opportunity to invest time and resources in modifying their home environment, creating artificial

habitat diversity within a geographical region and increasingly making their living by exploiting a range of *culturally* created niches. Those exploiting the "farming" niche needed to acquire different knowledge and skills than tradesmen, artisans and soldiers. Cultural divisions therefore develop between occupational categories. Just as those who share a niche in the natural environment share a desire to defend the physical resources present within their territory, those who exploit the same cultural niche share a desire to control access to the resources that their skills and knowledge allow them to acquire.

Modernization amplifies and extends the changes that began with the advent of agriculture. Before modernization, most people migrated as part of their family or social group. Modernization brings *individual* spatial and social mobility (Zelinsky, 1971). Individuals migrate to urban centers to work in factories and often leave their region or country of birth. Children attend school and have less exposure to the cultural variants of their parents and more exposure to non-family culture. In the terms developed by cultural evolutionists, oblique and horizontal transmission increases and vertical transmission declines.

The increasing inclination of Western mothers to return work soon after giving birth causes non-parental exposure to begin earlier in a child's life. In many cases, this results in infants being exposed to cultural variants from nannies and day care assistants who are temporary or first generation immigrants. Mass communication further increases the proportion of non-parental cultural transmission. More and more of the cultural variants available to members of a modernizing society are transmitted between people who are not kin, friends, countrymen or even acquaintances. Young people are therefore less likely to follow the ways of their parents and more likely to create novel recombinations of diverse cultural variants. As the modernization process continues, the choice of occupations, educational specializations and ultimately leisure pursuits available to young people increases. Individuals whose genetic inheritance is very similar might end up with a very different cultural endowment.

One consequence of the decrease in interaction between kin that accompanies modernization may be the fundamental cultural change that is characteristic of modernizing societies; people begin to limit the number of children they produce and birth rates decline sharply (Newson et al, 2005). Social interactions between kin are more likely to include encouragement or rewards behavior likely to lead to the expansion of the family than interaction between friends or work colleagues (Newson et al, under review). In modern social networks in which there is little contact between kin, the content of social influence is far less pronatal. Natural selection, therefore, favors people who have not embraced modernity or who have adopted other cultural variants associated with modernity but not the belief that it is better to have a small family. Anabaptist populations, for example, have a high birth rate and are increasing rapidly because enjoy the prosperity associated with life in modern North America but resist cultural influences from outside their kinship-based communities (Boyd and Richerson 2005: Chapter 5).

The size of modern populations and complexity of cultures and sub-cultures sharing the same space, resources and problems has forced an increased use of formal group decision-making. Councils and representative bodies are by no means an innovation

of modern cultures and have been observed in foraging societies (Boehm, 1996) but, as societies become more complex, increasingly sophisticated institutions are necessary to reconcile the interests of individuals and groups that have access to, or desire access to, the same space and resources. Individuals and groups that are culturally very different increasingly share problems and must agree solutions. Inevitably the increased use of decision-making bodies reduces cultural diversity because these bodies are authorized to limit the cultural variants available to the populations they represent.

The need to find compromises and make decisions that can be justified to all interested parties influences the decision-making process and inevitably the decisions themselves. Judgments must appear rational and consistent and (where possible) be supported by evidence and appeal to a set of values that is appreciated by all the interested parties. The success of a formal decision-making body depends on the extent to which the population approves of the choices they provide. One form of group decision-making process that is an innovation of modern societies is the survey or opinion poll through which putative "decision makers" can be guided on the decision to make. How the various formal decision-making processes might affect cultural change has not yet been studied by evolutionists.

The technological and social changes associated with modernization increase rather than decrease the range of cultural variants available for individuals to acquire. Paradoxically, this can give the impression of reduced cultural diversity. Although the choice is wide, the same range of choices is increasingly available all over the world, particularly in urban areas. The cultural institutions, practices and values necessary to allow culturally diverse groups to cohabit contribute to this impression. There is cultural evolutionary convergence on variants, such as convertible currencies, a publicly acknowledged criminal code with formal trials of those accused of transgressions, evidence-based decision-making, tolerance of diversity, respect for individual choice that make effective and peaceful transactions possible.

## Summary and Conclusion

It is useful to think of culture as a collection of "cultural variants" which are maintained in the minds or records of members of a population. This is analogous to the genes – the collection of "genetic variants" that are maintained in the gene pool of a species. Cultural change occurs by a process of evolution, as described by Darwin, which is analogous to but different in detail from biological evolution. The Darwinian theory and mathematical modeling tools used by population geneticists to understand changes in the gene pool over time can be used to understand and model cultural change.

It is transmission of cultural information from individual mind to individual mind that maintains culture variants in a population and it is the increased adoption some variants (including new variants) compared to others that drives cultural change. The adoption of cultural variants is not random; remembering a fact, developing an opinion or learning a skill, is the result of a conscious or unconscious decision by an individual. The pattern of adoption of cultural variants has been the subject of investigation by social psychologists and the findings are consistent with humans

having evolved psychological mechanisms which bias decision-making to increase the likelihood of an individual acquiring useful rather than maladaptive cultural variants. At the population-level, these biases can be seen as forces which influence the direction of cultural evolution. Our ability to understand cultural differences and change can be improved by systematic observations of the forces driving cultural evolution and the creation of testable hypotheses that predict outcomes as a result of social and environmental change. This creates huge scope for research in quantitative ethnography and cultural psychology. The topic may be almost endlessly complex but it is correspondingly endlessly fascinating and our understanding can improve with study.

Modernization brings rapid cultural change and we have presented here a demonstration of how cultural evolutionary theory can be used examine how modernization affects cultural diversity. Although it often suggested that modernization reduces cultural diversity, an evolutionary analysis suggests a more mixed picture. If diversity is defined as the number and variety of cultural variants available for individuals to acquire, modernization undoubtedly increases diversity. If, however, diversity is seen as regional differences in available culture variants, then it has decreased. In small-scale societies, the complexity and diversity of culture within societies is small, but the diversity between small, local groups is large. Waves of modernization over the last few thousand years have created complex cultures with substantial diversity within them but they destroy much small-scale variation in the course of their expansion. The formation of intermixing cultural groups, which began with the advent of agriculture and creation of population centers, increases rapidly with modernization.

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