Cultural Evolution

Peter J. Richerson

Distinguished Professor Emeritus
Department of Environmental Science and Policy
University of California Davis
Davis CA 95616 USA

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Introduction

Robert Boyd and I use the following psychologically based working definition of culture:

> Culture is information capable of affecting individuals' behavior which they acquire from other members of their species through teaching, imitation, and other forms of social transmission

By this definition, culture has proven to be widespread in the animal kingdom. The social transmission system of Norway rats was dissected in a classic series of papers by BG Galef (1988) and his colleagues. Andrew Whiten (Whiten, McGuigan, Marshall-Pescini, & Hopper, 2009), Michael Tomasello (Herrmann, Call, Hernandez-Lloreda, Hare, & Tomasello, 2007) and their colleagues have studied social transmission in apes and humans in a comparative framework. This work shows that chimpanzees are rather good social learners compared to other animals, but humans prove to be much better social learners than our nearest relatives. Human children are compulsive imitators. The quantity of information that humans can acquire by social transmission thus far outpaces that of any other species. Humans can thus build up complex cultural adaptations by cumulating successive innovations to eventually evolve structures and behaviors that rival organic adaptations in their sophistication and diversity. For example, beginning about 11,000 years ago, foraging peoples who harvested wild plants began to experiment with simple schemes for encouraging the plants they targeted (Richerson, Boyd, & Bettinger, 2001). Over the subsequent few thousand years, such experiments eventually resulted in the creation of a diverse set of artificial agroecosystems based upon domesticated plants and animals. Systems adapted to most climates and soils on earth evolved, ranging from root crop dominated systems in the poor soils of tropical rain forests to caribou herding near the Arctic Circle. In favored areas, agriculture led to dense settled populations, intricately adapted agricultural technology, and complex social systems. Humans are the only species we know that is highly specialized for social learning and cultural adaptations. These skills led to a cultural adaptive radiation that bears comparison with the rapid radiations hundreds of new species of fishes in large tropical lakes.

Cultural Diversity is Real

Early Twentieth Century cultural anthropologists built their discipline upon naturalistic observations of a large sample of the world's peoples. The ethnographic corpus emphasized simpler societies that roughly represent the past of the more complex societies. These scholars discovered a huge amount of variation in language, social customs, religion, kinship, art, and practical technology. The diversity among simpler

societies was as large as that between more complex ones, casting doubt upon simplistic stage theories of human evolutionary advance.

Later Twentieth Century scholars, especially those of a cognitive psychology bend, imagined that much of this diversity is relatively superficial, and that most phenomena of interest could be reduced to innate cognitive mechanisms with relatively little need to depend upon cultural explanations. Noam Chomsky's ideas about linguistics inspired a pioneering generation of evolutionary psychologists (Pinker, 1994; Tooby & Cosmides, 1992). Chomsky's "principles and parameters" picture of language argued that the cultural variation at the surface level of language could be explained by a limited number of innate principles with a few cultural parameter settings per principle. Similarly, Tooby and Cosmides suggested that much of the apparent cultural diversity described by cultural anthropologists could be explained by *universal* genetically prescribed cognitive rules that generate different behavior in different environments, independent of socially transmitted information. Twentieth Century biological anthropologists, by contrast, often emphasized genetic *variation* between human populations (Rushton, 2000).

In the last 20 years much evidence has accumulated that the Twentieth Century cultural anthropologists did not understate cultural diversity (Henrich, Heine, & Norenzayan, 2010). Many linguists have become convinced that language is culturally highly variable in ways that cannot be economically reduced to a few innate principles and a few parameter settings per principle (Evans & Levinson, 2009). Chomsky himself has become a minimalist as regards the innate structure of syntax (Hauser, Chomsky, & Fitch, 2002). A disproportionate share of the variation in human behavior between groups appears to be cultural not genetic (Bell, Richerson, & McElreath, 2009). Much interesting genetic variation has recently come to light (Hawks, Wang, Cochran, Harpending, & Woyzis, 2007), but much of it seems to be the product of gene-culture coevolution as discussed below.

The Population Level Properties of Culture Are Critically Important

Many evolutionary psychology hypotheses envision a direct connection between selection, cognitive capacities, and social adaptations. By contrast, cultural evolutionary explanations typically depend upon the "population level" properties of culture. The psychological processes of accurate imitation and teaching set up an inheritance system with many similarities to genes. Evolutionary forces play upon cultural variation in much the same way that selection and other evolutionary forces play upon genes, creating over time complex skills, concepts, attitudes, and even perceptions that have only simple precursors in our innate psychology. For example, Stanislas Dahaene (2009) has shown how the entirely novel culturally evolved skill of reading takes advantage of the object recognition system in the brain. Susan Carey (2009) has shown how cultural scaffolding allows children to acquire complex concepts by bootstrapping upon a small set of core cognitive concepts. No one mind needs to invent reading or other complex ideas by themselves. Rather, many minds working over many generations are typically responsible for complex cultural adaptations. Cultural evolution includes a number of processes that do population level work (Richerson & Boyd, 2005).

Random forces

Cultural mutation. Individual level errors in recall, performance and observation introduce variation into cultures

Cultural drift. Cultural elements can increase and decrease in small populations due to statistical sampling effects

Decision-making forces

Guided variation. Experienced individuals often discover new and better variants of traditional ideas and skills. The new variation introduced into cultures is not entirely random

Biased transmission. Individuals do not always passively accept traditional culture but can reach their own conclusions about new variants based on direct experience or on various decision-making rules of thumb such as adopting new variants if prestigious people adopt them. Collective decisions may be important, as when communities adopt new ideas by consensus

Natural selection. This force acts on any form of heritable variation. Darwin famously argued that ancient tribes would vary in terms of their loyalty and willingness to aid one another and that tribes that had more of these qualities would be more successful than those that had less. Cultural variation is as susceptible to natural selection as genes.

Cultural change is the net result of all of these processes acting in concert. Natural selection by itself is a population level process that generates complex adaptations, but this process is relatively slow. In the case of the evolution of genes, decision-making forces play limited roles, as in mate choice. They are much more important in cultural evolution. Ongoing communities of decision-makers can collectively drive cultural evolution much faster than can random forces and natural section alone. Human decision-making is unimpressive at the individual level, but aggregated over many individuals and generations of time it constitutes an evolutionary force that is as potent or more potent than natural selection. Even so, it took thousands of years and millions of people to “engineer” the complex societies, and the complex technologies that underpin them, by the processes of cultural evolution.

Why Did Cumulative Culture Evolve Recently in the Hominin Lineage?

The origin of human culture is one of the greatest puzzles in evolutionary science. Most of the important basic adaptations, such as sophisticated eyes and skeletons that contribute so much to the success of animals, originated hundreds of millions of years ago. Since rudimentary culture is widespread, we might expect that if complex culture is a decided general advantage, then it ought to be a widespread component of many species’ adaptations. Instead, it is restricted to one species, but a species that has proven extra-ordinarily successful. On the other hand, large brains are very costly organs (Aiello & Wheeler, 1995). If large, costly brains are required to acquire and manage human-scale culture, we might imagine that rather specific features of the environment are required to favor its evolution.

Coincidently or not, the earth's climates have gotten cooler, drier, and more variable over the whole Cenozoic , culminating in the exceedingly variable climates of the Pleistocene. The average brain size of mammals has also increased over the Cenozoic (Jerison, 1973). Recent high resolution ocean cores that have good paleoclimatic and paleoecological proxies show that the kinds of rapid high amplitude environmental fluctuations required in theory to favor a system of cultural evolution have increased during the last few hundred thousand years, as our ancestors evolved larger brains and more sophisticated cultures (Richerson, Boyd, & Bettinger, 2009). The ability of a cultural species to use decision-making, at the great cost of a large brain, was probably initially advantageous to adapt to a regime of high climate variability.

Gene-culture Coevolution Is Probably the Dominant Mode of Recent Human Evolution

Some classic evidence and considerable new genomic evidence suggest that much human genetic evolution was set in motion by the origins of agriculture a few thousand years ago. Current genetic evolution seems to be responding to the dramatic changes in the modern world (Laland, Odling-Smee, & Myles, 2010; Richerson & Boyd, 2010). If cultural evolution is typically fast relative to genetic evolution, we can expect that culture evolution has been the leading process in gene-culture coevolution for a considerable period of our evolutionary history, going back towards the middle Pleistocene at least. Gene-culture coevolutionary hypotheses are prominent in ideas about how languages (Tomasello, 2008), religion (Atran & Henrich, 2010), and large scale societies (Richerson, Boyd, & Henrich, 2003) evolved. Rudimentary Pleistocene cultures, in effect, created novel environments in which it became advantageous for ever more complex innate psychological dispositions to permit the cultural evolution of more complex languages, religions, and social systems. If this hypothesis is correct, the nature-nurture dichotomy that has bedeviled thinking for a century needs to be abandoned. Culture, genes, and individual experience are completely entangled by gene-culture coevolution. Charles Lumsden and Edward O. Wilson (1981) famously argued that the gene-culture coevolutionary process meant that culture was on a genetic leash. But if cultural processes are actually driving genetic evolution, it is by no means clear that genes control the coevolutionary process in the one-sided way they proposed.

Conclusion

The primary human adaptive specialization is the ability to imitate accurately and teach efficiently. The cumulative products of imitation and teaching constitute our cultures. The use of imitated and taught behavior allows us to adapt to rapidly changing environments and to create complex adaptations to most of the world's climates and ecosystems. Trying to understand human evolution without taking account of the population level properties of culture is like trying to understand the motions of planets without gravity.

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Suggested Reading

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