Is Science Postmodern: Cultural Evolution as an Example

Karl Frost
Graduate Group In Ecology
University of California—Davis

Peter Richerson
Department of Environmental Science and Policy
University of California—Davis

Submitted for inclusion volume on *Naturalistic Approaches to Culture*, edited by Csaba Pléh, October 31, 2012.

About 8000 words total

Introduction

We argue that many of the alleged differences between humanities- and science-based approaches to studying human behavior are largely mythical. We will illustrate using evolutionary approaches to human behavior as our exemplar. On the one hand, few humanist scholars understand the complexity of contemporary evolutionary theory and many of their perceptions of evolutionary theory are based on simplistic non-Darwinian ideas of 'progressive' evolution harkening back to the era of (distinctly non-Darwinian) Social Darwinism. On the other hand, many scientists using evolutionary theory to understand humans themselves fail to understand the complexities introduced by culture, and thus replicate past mistakes in applying evolutionary theory to human behavior in ways that excite the suspicions of humanists.

This debate is sometimes framed as two positions: postmodernists who believe that human culture is too complex and historically contingent to be studied effectively through context-independent, deterministic models of linear, progressive development; and evolutionists who believe that human behavior is definitively constrained by genetic fitness criteria and that the development of social forms follows directly from considerations of genetic fitness. We argue that there is at least one alternative position: cultural evolution and gene-culture coevolution. This position takes culture seriously as a collection of processes that that are fundamental to understanding human behavior. Culture has powerful and pervasive effects including having important effects on genetic evolution in our species. We hope that our effort to clarify the issues at stake in understanding human evolution will lead to a more productive discussion than the "science wars" of the past generation.

The theory of gene-culture coevolution exemplifies how a proper science of culture in fact echoes several of the themes that humanists take especially seriously. The basic idea is that human agency plays a large role in how culture evolves, a fact well described by Darwin (1874) in *The Descent of Man*. Cultures in turn create environments in which genes evolve. Because cultural evolution is rapid compared to genetic evolution, cultural evolution can play a leading role in the evolution of human genes. Clear cases of this process are known, and there are likely many more processes in which the agency of organisms can play a creative, even reflexive, role.

The “evolution-development” and “niche construction” research programs illustrate this kind of reflexivity in human history and individual development.

While there is not one single position that one could call “the postmodern” perspective, there are a number of recurring critiques of empirical social science generally, and evolutionary social science specifically, emerging from the humanities and more humanistic strains in the social sciences which are often collected under the term “postmodernism”. We do not attempt to address every extant critique in this article, nor say that cultural evolution theorists are in agreement categorically with all of them. Instead, we suggest that the position of cultural evolutionists often parallels that of postmodern theorists concerning many issues centered on the interconnectedness and complexity of culture, the historical contingency of social development, the importance of human agency, the awareness scientists have of the limits to their own perspective, and the utility of qualitative versus quantitative methods. Moreover, while these critiques do have legitimate targets within the self-identified community of scientists, this community, as that of the humanities, is represented by a wide variety of perspectives. The “science wars” have traded on stereotypes that are not conducive to useful discussions.

Cultural Evolution

For our purposes, it is useful to think of culture as that body of knowledge, opinions, skills, norms and so forth that humans learn from other humans by imitation and teaching (Richerson and Boyd 2005). Other social organisms have simple forms social learning, but human psychology and human development are highly specialized to support the relatively accurate and faithful acquisition of large amounts of quite complex information by imitation and teaching. This is not necessarily the only useful definition of culture; but we claim it is a useful definition because it highlights the limitations of theories based on the simple genetic evolution models criticized by both humanist scholars and cultural evolution theorists.

Culture obviously changes over time. At least in most contemporary societies, change is rapid enough to be observed by everyone. We variously celebrate and deplore such changes, but no one denies them. Perhaps in the past, societies changed so slowly that the people involved did not notice; but historians, archaeologists, and paleoanthropologists have certainly documented that they did change.

To "naturalize" cultural evolution we advocate a strategy pioneered by the psychologist Donald Campbell (1965) and first put in mathematical form by Luigi Cavalli-Sforza and Marcus Feldman (1973). The work starts with the idea that culture is a system of inheritance. This idea follows directly from the definition above. We acquire culture from other individuals by teaching and imitation much as we get our genes from our parents. The existence of a fancy capacity for high-fidelity imitation is one of the most important derived characters distinguishing us from our primate relatives, who have only relatively rudimentary abilities to imitate and teach. We are also unusually docile animals with innate norm-psychology. We are unusually sensitive to expressions of approval and disapproval from parents and others, and we are innately primed to imitate others, teach, establish group norms, and enforce those norms (Tomasello, Carpenter, Call, Behne, & Moll, 2005; Csibra and Gergely, 2011). Thus parents, teachers, and peers can shape our behavior easily and rapidly compared to training other animals using more expensive material rewards and punishments. Finally, once children acquire a language, parents and others can communicate new ideas quite economically to those who do not know them. This economy is only relative. Although we get our genes all at once at the moment of conception, acquiring an adult cultural repertoire takes some individuals two decades. Humans ultimately acquire a repertoire of culture that rivals the genome in size and complexity. We have used the faculty for culture to create a stunning diversity of subsistence technologies, social institutions, arts, crafts, languages, and belief systems. Biologists have known since Darwin's (1874) discussion "On the Races of Man" in the *Descent* that all humans are a single biological species with rather trivial organic differences between them:

> The American aborigines, Negroes, and Europeans are as different from each other in mind as any three races that can be named; yet I was constantly struck, while living with the Fuegans on board the "Beagle," with the many little traits of character showing how similar their minds were to ours; and so it was with a full-blooded Negro with whom I happened once to be intimate. (Darwin 1874: 237).

Yet, in a cultural sense, we are something like a vast adaptive radiation (the evolutionists' term for a swarm of species with a recent common ancestor but having evolved adaptations to diverse habitats). Our cultures do differ from a biologist's "good" species in that ideas can spread fairly readily from one culture to another, much as genes can in bacteria. Darwin contrasted the organic similarity of humans of different races with differences arising from different customs:

> As it is improbable that the numerous and unimportant points of resemblance between the several races of man in bodily structure and mental faculties (I do not here refer to similar customs) should all have been independently acquired… (Darwin 1874: 239).

Using modern data and statistical methods it seems that humans are at least ten times more variable culturally than genetically (Bell, Richerson, and McElreath, 2009).

The existence of cultural transmission means that culture has what evolutionary biologists call "population level properties." Individuals' behavior depends on the behaviors common in the population from whom they acquire beliefs just as individuals' anatomy is dependent on the genes common in the population from whom they acquired their genes. Teaching and imitation mean that any individual's ideas are potentially immortal and might influence every future human. Cultures are webbed together by teaching and imitation in something like the same way species are webbed together by the transmission and recombination of genes through sexual reproduction.

The cross-cultural diversity of human behavior is staggering, but for the most part we are limited to learning those behaviors extant in our culture in our time. In the long run, the commonness or rarity of culture in a population is a product of what happens to the individuals who teach others or not, and those who are imitated or not. The analogy is more than a curiosity because population biologists have developed a formidable kit of empirical and theoretical tools to analyze this intricate interplay between the individual and population level. In the terms sociologists often use, population biologists have the means to make the sociologists' macro-micro problem tractable. By now, a considerable number of empirical and theoretical scholars pursue cultural evolutionary research strategies (Mesoudi 2011).

In this exercise, we think it best to wear the analogy between genes and "memes" most lightly. For example, we have resisted using the term "meme" to describe the "unit" of cultural transmission because the basic structure of culture need not be unit-like or otherwise more than very loosely analogous to genes. Culture is most un-gene-like in many respects. People can inherit acquired variation culturally (what one person invents another can imitate). We are not necessarily blind victims of chance imitation, but can pick and choose among any cultural variants that come to our attention and creatively put our own twist on them. We do not have to imitate our parents or any other specific individuals, but can instead be open to a better idea from any member of our social network or from media like books and television. The innovative part of the Darwinian analysis of cultural evolution has been to explore the impact of such differences on the cultural evolutionary process, letting model results and the existing empirical facts, not analogies, guide the research. Substantively, cultural evolution turns out to have its own unique adaptive properties and its own unique suite of characteristic maladaptations, some examples of which we discuss here. Humanists are taught to believe that Darwinian analysis is an ideologically freighted form of scientism, which some versions of it certainly are. But at root Darwinism is just a set of observational, experimental, and mathematical tools that are useful to understand how individual and population level processes interact.

Maladaptations are epistemologically more interesting than adaptations. The trouble with adaptations is that the competing theories—creationism, genetic fitness optimizing, cultural evolution, macrofunctionalism, rational choice theory—all predict that adaptive behavior will be common. Each theory's predicted maladaptations, however, are much more distinctive. For example, W.D. Hamilton (1964) deduced from the principles of natural selection acting on genes that organisms should engage in altruistic acts only in proportion to the degree that they share genes. In his famous $b/c > 1/r$ rule, b measures benefits of an act ego performs for a recipient individual, c measures the cost of this act to ego, and r measures the proportion of genes shared by ego and recipient. In most cases, the maximum r can be is ½ (parents and offspring or full siblings) and drops off rapidly for more distant relatives. Since in most animal species, individuals have only a few relatives with appreciable r, Hamilton's theory predicts that altruism will be massively undersupplied compared to the mutually most beneficial case where help to others is supplied whenever $b/c > 1$. Every individual would be better off if every other followed the $b/c > 1$ rule instead of the $b/c > 1/r$, but natural selection on genes cannot favor such acts. With the exception of humans and a few other special cases, Hamilton's rule predicts the maladaptively low amount of animal cooperation quite well. The dilemma of cooperation, often illustrated with the parable of the Prisoners' Dilemma Game, has apparently been hard for evolution to solve. Human societies are a theoretical puzzle because they typically include much cooperation between distantly related and unrelated people. We have adaptively evaded a rule that otherwise seems to have nearly the law-like force of a physical principle, given genetic inheritance. Cultural evolutionists argue that cultural inheritance and evolution preserve more variation between groups of unrelated and distantly related people than can genes, leading to selection for tribal and larger scale cooperation in our species (Richerson and Henrich 2012). Moreover, the processes of cultural group selection are diverse. Imperial systems like China and Rome spread in part by military conquest of smaller or weaker societies, followed by assimilation to the culture of the victors. People also learn from the successes of their neighbors and voluntarily migrate and assimilate, often importing ideas that the host culture finds useful.

The unique features of the cultural system of inheritance are predictable from the elementary consideration that selection on genes to increase our capacity for social learning would surely not have favored this rather costly system if it did only what genes could do for themselves. One important advantage of the cultural system is the linkage of individual and collective decision-making processes with transmission to create a system for the inheritance of acquired variation. Given that decision rules partly derive from the action of selection on genes and hence are adaptive, on average at least, a system that responds both directly to natural selection and to adaptive decision-making forces will be able to adapt to varying environments more quickly than one that relies only on genes and non-transmitted learning. Strategically plagiarizing the learning of others, while also learning yourself when the opportunity arises, creates a system that can adapt swiftly to new conditions without the crippling expenditure of effort on individual learning. Individual learning is heavy lifting, and culture allows us to share this load among many individuals. This system has roots in the common capacity to transmit simple behavioral variants by social learning, as has been well studied in our closest relatives the chimpanzee (Whiten et al, 1999). But chimpanzees’ (and all other social learning species so far studied) social learning skills are rudimentary compared to humans (Tennie et al., 2009; Dean et al., 2012).

Secondly, accurate and rapid social learning allows humans, but seemingly not other species, to accumulate innovations that build up over historical rather than organic evolutionary time. These trans-generational cultural adaptations are often more sophisticated than what individual people could possibly have invented for themselves. The Arctic adaptations of the Inuit and their relatives, and the ocean voyaging adaptations of the Austronesians (Polynesians and related peoples) are examples. Human cultural adaptations are not only dramatically different across space and time, but are also as complex as organic adaptations that would have taken much longer to evolve. The Inuit adaptation to the Arctic and the San adaptation to the Kalahari are impressively complex and impressively different on a scale that would result in different species if accomplished by organic evolution. In support of these theory-derived conjectures, we note that humans evolved during the Pleistocene, a period of high frequency climatic variation (Richerson and Boyd, 2005), and that we became an unusually widespread animal by middle Pleistocene times. The ability to adapt quickly to a temporarily variable environment is easily put to use in spatially variatiable environments as well, allowing a tropical ape to adapt to life in temperate and eventually periglacial climates. We eventually became completely cosmopolitan, devising subsistence strategies tailored to practically every terrestrial and amphibious habitat on the planet. We believe that the ability of the cultural system to rapidly create sophisticated adaptations to ephemeral niches was the main advantage that paid the overhead costs of our large brain and long learning curve.

The hominin lineage probably had rudimentary forms of culture stretching back to our last common ancestor with the other apes. Oldowan stone knapping goes back to 2.6 million years, and quite sophisticated stone tool-making goes back at least 100,000 years. Discoveries in Africa keep pushing back earliest dates for various techniques. Over this long span of time, genetic and cultural evolution most likely became entangled. Genes certainly must have adapted our brains and behavior to acquire and manage culture. Much cultural variation is obviously adapted to promote human survival and reproduction, as Julian Steward (1955) and his followers demonstrated long ago. Charles Lumsden and Edward Wilson (1981) argued that gene-culture coevolution would lead to powerful selection on genes to keep culture on a leash so that cultural evolution would be tightly constrained to be adaptive.

Probably, no one doubts that the mechanisms considered by Lumsden and Wilson are important. Humans have used cultural adaptations to become a strikingly successful species; our genes have benefitted from our having culture. But that is only part of the story. Because cultural evolution is so fast in comparison to genes, culture may both be on a long leash and be strong enough to drag genes about. If a novel cultural variant arises that is not restrained by an existing genetic leash, genetic evolution of such a leash would be limited by the likelihood of random mutation to generate a genetic variant that could act as leash. If such a genetic leash were to arise, culture would likely have already moved well beyond the original variant, making the new genetic variant irrelevant. While a simple genetic reduction in social learning ability could potentially eliminate this behavioral genetic problem, it would also throw out the benefits of culture, thus limiting success in the immediate future. Human culture, on this argument, was and is a successful adaptation for human genes precisely because the genetic leash is very long, allowing cultural processes to let human cultures range widely in a search of successful adaptations to diverse environments. Thus, cultural evolutionists have come to roughly the same conclusions about the relative roles of genes and culture in human development and history as have many humanists.

The theory of cultural evolution is curiously parallel to the concept of “social construction.” The role of genes in cultural evolution is important, but the most innate capacity special to humans is the capacity for imitation and teaching that allows a lightly guided process of cultural evolution to explore huge design spaces in spheres such as social organization, technology, art, language, and religion. Diet provides an illustrative example. Human cuisines obviously have to satisfy basic requirements for protein, energy, and essential micronutrients, and genetic leashes certainly help select cuisines to satisfy these requirements. No humanist would deny genes have such a role to play. They and cultural evolutionists merely point out another obvious fact. These basic requirements have been satisfied in a host of different ways as cultures exploit a diversity of wild and domestic resources using cooking and a large variety of other processing techniques to make otherwise inedible things edible. We can still eat many of the same lightly processed or unprocessed foods like ripe fruit that our ape ancestors and relatives depend upon, but these make up a modest fraction of most cuisines. Rather, we have used culture to crack food resources that are difficult for other apes to exploit, and we do this over and over again in almost every terrestrial and amphibious environment on the planet.

Wide-ranging culture, in turn, seems to have played a large role in shaping human genes. Culture creates novel environments to which genes have to adapt. Because cultural evolution is faster than genetic evolution, culture-led gene-culture coevolution seems often to have used the leash to take genes on a culturally determined walk. Selection for physiological adaptations to plant rich diets and various adaptations to epidemic diseases in the wake of agriculture and the associated increase in settlement density are well documented (Laland, Odling-Smee, and Myles 2010; Richerson and Boyd 2010). So far the evidence is less striking for evolutionary events deeper in the past but a reasonably good case can be made that the innate aspects of our social psychology were shaped by tribal scale selection for culturally transmitted cooperative social institutions. If we want to look at it this way, cultural evolution has played an active leading role in shaping human genes. In some non-trivial sense we can say that human nature is socially constructed and we arrive at this conclusion via wholly naturalistic assumptions.

It must be said that the picture we have just painted highlighting the creative role of cultural evolution in human evolution is fiercely contested by some evolutionists. Edward Wilson (1998) remains a “tight leash” genetic reductionist, and certain evolutionary psychologists doubt that what we call culture plays anything but a strictly subordinate role in human adaptation (Tooby and Cosmides, 1992; Pinker, 2010).

We now turn to the way cultural evolution and gene-culture coevolution relate to important issues raised by postmodernist humanists and humanistic social scientists.

Historical Contingency

Some humanists and scientists hold history and science to be antithetical human endeavors. In this view, history seeks to explain the development of human behavior through sequences of idiosyncratic events, while science seeks to define physics-like absolute laws of human behavior that are context independent. This is a false dichotomy (Boyd and Richerson, 1992). It is easy to show that natural selection generates historically contingent patterns of change. True, the simplest models of selection acting in the simplest environments act like classic exceptionless scientific “laws.” However, real environments and more realistic models generate much more complex and fundamentally unpredictable trajectories of change. Empirically, we see the impact of historical contingency in evolutionary biology when we look closely at suites of organisms living in similar environments in different biogeographic regions. While we observe many convergent similarities in, for example, wet tropical forests around the world, there are many conspicuous failures of convergence as well. In the tropical and subtropical Americas, the hovering hummingbirds are a diverse group of nectar-feeding and pollinating birds. In Africa, the perching sunbirds are the principal specialized nectar feeders and pollinators. The forms of flowers in the two regions have coevolved with the hovering versus perching habits of the principle pollinators. In this sense, Darwinian evolution actually predicts that trajectories of change will be historically contingent, being based fundamentally on the occurrence of essentially blind, random variation. Once one moves beyond the (much too commonly used) oversimplifications of evolutionary equilibrium to frequency dependence of fitness, interactions between different variants, and developmental and niche construction feedbacks on evolutionary trajectories, historical contingency becomes even more important. Not only does Darwinian evolution predict path dependency of change, it also predicts that fitness will generally only maximize fitness locally. More fit species may exist, for historical reasons evolution may not have discovered them. Empirically, the frequent success of species introduced from other biogeographic realms suggests that not every species that could have evolved in a particular realm actually did so.

The history versus science argument has a long history. One of the best-known early proponents for the 'physics-like' notion of social development was Spencer, who in the 1800s advocated a non-Darwinian, progressive model of evolution. From Spencer, we inherit the common misunderstanding that evolution predicts clear trajectories of social change, from the primitive to the modern. The highly deterministic physics of the day was taken as the basic model of scientific knowledge. Boas contrasted these early notions of cultural evolution with his idea that cultural development would be locally idiosyncratic, based on local innovation and diffusion of cultural variation, which are the foundations of modern cultural evolution theory (Boas, 1887). Boas's fieldwork program was devoted to the documentation of cultural variation and the quest for regularities. His conclusion was that context independent regularities in human development were much rarer than popularly thought and that where they existed, they were often riddled with exceptions. He arrived at this conclusion, however, not by argument against empiricism as methodology, but through empirical observation using both quantitative and qualitative methods (Lewis, 2001).

It is not a question of whether to use models or not, but of which model to choose. Cultural evolution models based on social learning actually predict historical contingency, and long standing empirical observation supports this position – a position shared by some postmodernists and scientists.

Agency

In the debate about the relevance of social structure versus agency in the ongoing construction of and possible changes to social relations, agency is conceived as the freedom of motion of individual agents delineated by the social structure, and social structure is conceived of in terms of these limitations (Giddens, 1976). Empirical approaches to social science are often criticized for simplifying away important variation in individual perception and agency. Noting the structural importance of individual decision-making many, including Weber and Watkins, have argued that in order to understand a system, we must understand it from the perspective of the individual, thus advocating methodological individualism (Watkins, 1957; Weber, 1922). Sidestepping the philosophical question of the nature of free will, we look at agency as a range of behavior and consider its relevance as a question of the reflexivity between agency and structure. We find strong agreement between Giddens' theories of structuration and cultural evolution models which, taking the strategy of methodological individualism, model social systems as assemblages of individuals (agents) who behave in ways strongly affected by society via processes of social learning (imitation, conformity, teaching, indoctrination, etc). In these models, agents are not treated in a physics-like, deterministic fashion, but probabilistically, reflecting the range of behavior possible within the structure of society and indicating our inability to predict precisely what individuals will do within that range. The random element in the models reflects culture's ability to explore "design spaces" in a historically contingent and creative way. Theoretical social forces like conformism and group norms are modeled within cultural evolution as individual tendencies to conform to observed dominant behaviors in a social group.

Structure in cultural evolutionary models arises from individual psychology, albeit integrated over many individuals and over time, all in a particular historical and ecological frame. In this way, cultural evolution models are mathematically precise versions of specific models of structuration. Moreover, the specific choices made by individuals may or may not be important for the cultural evolution of the population, depending on the specifics of the model. In some instances, a choice may be overwhelmed by other factors. In others, a single innovative choice could change the trajectory of the whole system in vital ways. Of course, most individual innovations wink out without significant effect, but the root of most significant effects will lie in innovations made by individuals. Taking the approach of methodological individualism as a starting point, cultural evolution models predict the possibility of stable structuration through a feedback between individual choice making and structure manifest through observed choices of others. This echoes Bourdieu's idea of the habitus and field (Bourdieu, 1977). Cultural evolution goes beyond these static models, however, demonstrating other contexts in which the agent/structure or habitus/field relationship will be destabilized by cultural innovation, the product of human agency.

Comment [NN1]: It would be nice to discuss the parallels between habitus and CE theory in greater detail.

In cultural evolution models, we speak of "decision-making forces." Some of the most important forces acting on culture are the choices individuals and groups make in deciding what ideas, skills, attitudes, opinions and so forth to adopt. Darwin, in the *Descent of Man*, spoke of such forces as the example of the best people, customs and public opinion being the more important causes of moral progress than natural section in "civilized times" (1874: 192) (Not that he thought that selection had no role at all to play in civilized times). Leaving open the empirical question of decision-making biases driving moral progress as envisioned by Darwin, it is clear that Darwin envisioned important roles for this kind of individual decision making in the evolution of culture, in potential opposition to simple natural selection. Models of cultural evolution not only utilize these kinds of decision-making possibilities, but also predict that they will arise via processes like cultural group selection (Richerson et al., n.d.). The vast diversity of human subsistence systems, social institutions, languages, artistic creations, religions, and philosophies testifies amply to our individual and collective creativity. Harnessing creativity more efficiently than genes can do is the most significant feature of culture.

Complexity and diversity versus linearity, and truth versus prediction

A number of critiques of scientific methods revolve around the complexity of human society. While all but the most extreme versions of the critique of science accept the utility of the (relatively) simple deterministic laws of physics in predicting the phenomena they claim to model, postmodernists posit that the extreme complexity and interconnectivity of human society makes for a system that will not be explainable through simplified mathematical models. Starting from Heidegger and continuing with Weber and others, the primary criticism is that scientific projects attempting to discover universal laws and deterministic linear processes of social development from primitive to more advanced are doomed to failure. Lyotard famously characterized postmodernism as a healthy skepticism of metanarratives. Lyotard claimed that while objective reality may exist, it is impossible to discover a true model of underlying phenomena through which other models can be explained (Lyotard, 1979).

While this critique does have legitimate targets within science, many natural and social scientists agree that such universal, physics-like laws are not likely to be found in human behavior and many other complex phenomena affected by historical contingency. These conclusions come out of a mathematical analysis of complexity. Darwinian cultural evolution specifically does not posit a linear progression of social organization, except in very specific constrained circumstances, where both the environmental circumstances *and* the range of cultural variations repeat. For example, Esther Boserup (1965) showed that, contrary to the Spencerian model of linear cultural development from hunter gatherer through horticulture to modern agriculture, the development of agriculture is instead driven by population size. Robert Netting (1963) showed that agricultural advancement was, in fact, reversible with reversing population densities. Cultural evolution argues that this pattern repeats due to strong selection pressures combined with a reliably stable toolkit of agricultural techniques available in the cultural repertoire (which includes memory and learning across social groups). Where cultural selection pressures are not so clear and strong and where there is no stable toolkit of cultural variants to be selected on, cultural evolution predicts a proliferation of cultural variants and has further reason to predict widespread diversity and non-linearity of social development.

Biologists realize that the phenomena they study are exceedingly complex. As ecological statisticians Burnham and Anderson (2002: 20) put it, “we believe that ‘truth’ (full reality) in the biological sciences has essentially infinite dimension, and hence full reality cannot be revealed with only finite samples of data and a ‘model’ of those data.” This view is echoed by Mayr (1962). Boas viewed culture similarly (Boas, 1887). The number of relevant variables is too large to ever generate in the real world a data set large enough to test every hypothesis of interest. The best we can hope for are context-specific rules or tendencies that tend to break down out of their (usually unknown) contextual boundaries. Many biologists and social scientists are thus postpositivist. Human cultures exhibit the same complexity and diversity as other biological phenomena. Very many questions can be asked about human phenomena; there are no authoritative final answers to any of them. At best, we may be fairly certain that some answers to a given question may be contextually and conditionally better than others. We agree with Lyotard in this sense, that if there is an objective truth or metanarrative, it will be beyond our limited ability to model, and so we are limited to a plurality of narratives (models) which are contextually applicable.

If the complexity and diversity of evolving genetic and cultural systems cannot be understood in terms of general laws, can we do science at all? The approach that has evolved in evolutionary biology and ecology supposes that we have some hope of understanding complex and diverse phenomena, but only locally (Richerson and Boyd 1987; Burnham and Anderson 2002). A particular instance of evolution has likely been influenced by many different factors, some strong, some weak. With limited data—and data is always limited—we can hope to explain only the strong factors. But the strong factors in one case will not be the strong factors in other cases. Therefore we try to have as large a toolkit of candidate explanations as we can in the hopes that one or a small set of models can capture the strong effects in as many cases as possible. With a large box of sound tools, we will be better equipped to account satisfactorily for a wider range of the phenomena we encounter and to create useful predictions in a wider array of circumstances, always with the proviso—expectation even—that in the future better tools and more data might make the current best explanations seem quite naïve.

Thus, it appears vain to hope for a "totalizing" metanarrative, or Truth, that society is the sum of individual actions. As Burnham and Anderson (2002: 58) point out, in deriving an information theoretic goodness of fit measure to compare how well alternative models fit the data, an assumed "full truth" term in the derivation becomes an irrelevant constant. In the end, we can estimate from our data which of our models is closer to "full truth" but only relative to the other models. We don't have any idea how far our best model is from "full truth!" The information theoretic approach also penalizes models in a principled way for their complexity. This is because overly complex models will fit the noise in our data as well as whatever slivers of truth we can extract from it, distorting our picture of the slivers themselves. Thus, we are generally forced by the limitations of our data to work with quite simple models compared to what we know is an ever so much more complex "full truth." The question then becomes whether the prediction is useful or not, not whether or not it is "true." Bayesian and information theoretic model comparison methods (like AIC and BIC) formally account for a priori assumptions of model probability and for the amount of available data when comparing the relative utility of different predictive models. In this way, the relative usefulness of the models depends on individual perspective in terms of assumptions (priors), experience (data), and values (questions asked), as well as on the models to which they are being compared. Thus, many scientists today agree with Max Horkheimer's critique of positivism and his claim that scientists will always be limited by their own available perspectives (Horkheimer, 1972). From this position, we understand the necessity for a debate of values and always maintain an openness to incorporate new data and new models.

Thinking about systems of inquiry such as biology and human behavior, and understanding the purpose of model construction not as objective "Truth" finding, but as developing relevant predictive tools, we can discuss then when such tools work well and when they work miserably in terms of helping us make functional decisions. Our *understanding* of a system boils down to having a good hunch of what models will work best in what situations. Trader-statistician Nasim Taleb provides a very timely example of this issue writing about the reckless financial decision making of government and Wall Street economists in the run-up to the 2007-8 financial crisis (Taleb, 2008) (See also Whitehead and Richerson, 2009). Economists deploy enormous amounts of resources generating large data sets to make predictive models in which there are vast sums of money to be gained or lost. As such, one can expect that within certain contexts, specifically, near the data set, predictions should at least be better than chance, which they do tend to be. These models will often be a best-fit model given the data used to generate the fits. Taleb, however, divides the world of decision-making into four quadrants based on two variables: 1) complexity of the relationship between the variable analyzed and the policy decision, and 2) the containment of the variation in the variable. Where variations in events of interest are characterized by extreme events being relatively common (variation is not well contained) and where the impacts of these events are highly sensitive to this variation, we can expect that our models will be worse than useless. Much economic theorizing is based on the mathematically tractable normal distribution, but in the real world extreme events are more common than predicted by the normal. Variation in economic data, such as returns from the stock market, set a trap for the unwary modeler. Short runs of data are adequately fit by simple risk models based on the normal distribution of variation. Typical economic datasets are not long enough to adequately fit more complex models. But we do know qualitatively that variation in returns to the stock market are dominated by big, rare events like the Great Depression and the late 20th Century stock market boom, of which a dataset may have only one or two exemplars – too few to guide model fits. As Taleb writes, "no model should be better than just any model" in this situation. This is specifically the kind of region that economists were claiming that their models fit: prediction far outside of the range of their data and applied to variables whose policy implications were highly complex. To paraphrase Taleb, a blind guess would have been better, for then it would have at least been transparently random in its relationship to reality. Economists were steering the global economy using models they knew or should have known to be wildly inappropriate. Their normal models fit their data well, but a qualitative understanding of long economic time series, and the fat-tailed nature of real world more generally, should have been enough realize that the models were dangerously unrealistic.

Interestingly, statisticians working on highly applied problems, such as Burnham and Anderson and Taleb cited above, have given us some of our deepest insights into the limitations of scientific methods. Both of us have been applied scientists at points in our careers. Applied science highlights the risks of being wrong. Basic scientists who get the wrong answer damage their reputation. Applied scientists who are wrong damage their reputations *and* those harmed by their mistake. Applied science is also usually political, forcing applied scientists to deal with variations in world-views and ethical principles that basic scientists have the luxury of ignoring. They see exercises of political power on a scale larger that the departmental space committee and the infighting over awarding grants and publishing papers.

To restate, postpositivist science is not centrally concerned with Truth, but in understanding and prediction on a much more local scale. Evolutionists and ecologists have become rather humble about what they hope to know and apply in the face of problems of "essentially infinite dimension." Perhaps economists have now learned this lesson, too. For example, in the late 20th century applied ecologists developed the strategy of "adaptive management" (Walters and Holling 1990). The concept takes it for granted that we understand only a fraction of what is going on in any ecosystem. Management activities will inevitably be based on incomplete information and inadequate models. Such activities are comparable to experiments. We can anticipate that they will often have unforeseen consequences, but by studying them as experiments we can hope to acquire more and better data, improve our models and do better next time. We can also anticipate that external shocks or our own activities can trigger important variation on dimensions that not vary enough to be important in the past. There is a sort of "law of conservation of ignorance" at work. We cannot know the Truth about any complex, historical system, and even if we could, it would not remain the Truth for long.

We could not agree more with postmodernists, in this case, about the dangers of claims to a metanarrative, a context-independent universal model. Issues of such inappropriate claims of knowledge will continue to have vitally important global economic and political ramifications.

Qualitative versus quantitative methods

In his call for interpretive methods and hermeneutics, Heidegger points out the limitations of quantitative analysis, the necessary simplification in order to translate a rich and complex situation into numerical language. Some humanists from this point of departure make rather bold claims about the unsuitability of numbers for understanding certain phenomena. Similarly, there are scientists who turn their noses up at qualitative research, suggesting that truth only comes with quantification. This is another false dichotomy. Many, if not most, practicing social scientists understand the mutual support and contextual utility of quantitative and qualitative methods. Most evolutionists, ecologists, and geologists are proud of their qualitative natural historical abilities. Ethnographers, historians and others interested in humans use the same techniques. Acute observations and ordinary reasoning are the quickest and cheapest way to get a general feeling for a phenomenon of interest (Henrich and Henrich, 2007: 3-4). Many quantitative research questions emerge out of the hard ground work of exploratory qualitative research, and arguably the big picture of any complex system can not be understood without the kind of thick description advocated by Geertz (1973). As Donald T. Campbell is quoted as saying, "All research ultimately has a qualitative grounding" (Miles & Huberman, 1994). See also Leijonhufvud (1997).

At the same time, our qualitative reasoning skills are not terribly well suited to rigorous logic and our raw observational skills deal with quantities quite poorly. Verbal reasoning can be handicapped by the imprecision of word meanings and by polysemy. Mathematical models and quantitative observation are merely prostheses or instruments to aid the mind, rather like spectacles, telescopes and microscopes aid the eyes. In the contemporary approach to hermeneutics, called objective hermeneutics, this is referred to as the efficiency of quantitative methods (Oevermann, Allert, Konau, & Krambeck, 1987). Translation into mathematics simply makes our descriptions more precise, which does not make them more true, but facilitates the assessment of their accuracy relative to other descriptions of the system. Mathematics makes for a narrow, precise picture of a detail or a dimension of a system, whereas qualitative methods give a broad and rich but soft focused narrative about a system. The question becomes one of when the sacrifice in terms of richness of description is justified by the precision of analysis, a question that rests on the qualitative hermeneutic research which set the parameters of debate and the values which guide research.

The Bayesian theory of empirical inference formalizes a relationship between quantitative and qualitative methods. First we distill all our basic understandings of the problem at hand to construct our priors. Much of this exercise is typically qualitative. For example, we may have good qualitative grounds for suspecting that our problem's variance is dominated by big rare events. Then we consider quantitative data and update our priors. If our time series inadequately resolves big rare events, we will hardly adjust our priors at all after considering the data. The problem is dominated by big rare events, uncertainty is high, and the quantitative data we have does little to reduce the uncertainty. Better to understand this than take action on a bogus quantitative model whose precision is an illusion.

Far from ignoring qualitative research, empirical social science essentially rests upon it. Qualitative and quantitative research support each other. In a sense, quantitative research, being simply a formal translation of specific simplified verbal models into the language of mathematics, is no more than a specific breed of qualitative description that is amenable to more efficient methods of analysis and more precise and accurate application of logic. The question of the utility of qualitative description versus quantitative models is essentially then one of model comparison, and the answer of relative utility is dependent on available data and the question being asked. What becomes interesting is when methods are combined in a single analysis. When qualitative and quantitative studies agree, we feel more confident in an assertion. When they disagree, we become doubtful of our ability to predict the situation and new research questions are opened up. Neither method is *a priori* closer to the truth.

Conclusion

The thesis of this chapter is that there is less disagreement then is often presupposed between what are considered postmodern critiques of science and the views of many scientists themselves. The communities of researchers engaged in interpretive versus empirical approaches to the study of human behavior both have wide ranges of opinions. Not only does the range of opinions within the two communities have significant overlap, but so do the communities themselves, as individual research groups use both qualitative and quantitative approaches to given questions to avail themselves of the complementary strengths of both methods. We do not attempt to engage with all extant critiques of quantitative social science. For example, it is beyond the immediate scope of this chapter to address the issues of power and privilege in science or the distorting power of money on science We confine ourselves to noting that we basically agree that all rhetorical forms have their own scopes of power, and that evolutionary biologists in the thick of biodiversity conservation fights or environmental scientists and policy scientists dealing with the highly politicized fight over global warming are fully aware of this from their own personal experience. We instead take up the more humble goal of showing how many contemporary qualitative social scientists and cultural evolutionists, particularly, are in agreement with some of the claims frequently described as critical postmodern perspectives. The stereotyped view of a two-position debate between postmodernism and empirical social science fails to capture this agreement around the historical contingency of culture, the importance of human agency in the trajectories of culture, and the inaccessibility of Truth due to the complexity of cultural systems. Moreover, these social scientists, particularly ones using the theories of cultural evolution, do not just take these positions as a priori assumptions, but actually arrive at these findings from empirical study and the logical implications of their models. As social scientists, we join in the chorus of criticism of those who attempt to use inappropriate models of human behavior to direct government policy. Finally, the arguments about qualitative versus quantitative work have become in recent years more clearly refined, allowing us to understand the contextual usefulness and mutual support of each quantitative and qualitative methods.

References

Bell, Adrian V., Peter J. Richerson, and Richard McElreath. "Culture Rather Than Genes Provides Greater Scope for the Evolution of Large-Scale Human Prosociality." *Proceeding of the National Academy of Sciences USA* 106, no. 42 (2009): 17671-74.

Boas, Franz. *The Study of Geography*. New York: Macmillan, 1887 [1940].

Boserup, Ester. *The Conditions of Agricultural Growth: The Economics of Agrarian Change under Population Pressure*. London: Allen & Unwin, 1965.

Bourdieu, Pierre. *Outline of Theory of Practice*. Cambridge: Cambridge University Press, 1977.

Boyd, Robert, and Peter J. Richerson. "How Microevolutionary Processes Give Rise to History." In *History and Evolution*, edited by Matthew H. Nitecki and Doris V. Nitecki. 179-209. Albany: State University of New York Press, 1992.

Burnham, K.P., and D. Anderson. *Model Selection and Multi-Model Inference.* Berlin: Springer Verlag, 2002.

Campbell, Donald T. "Variation and Selective Retention in Socio-Cultural Evolution." In *Social Change in Developing Areas: A Reinterpretation of Evolutionary Theory*, edited by H. R. Barringer, G. I. Blanksten and R. W. Mack. 19-49. Cambridge, MA: Schenkman Publishing Company, 1965.

Cavalli-Sforza, Luigi L., and Marcus W. Feldman. "Cultural Versus Biological Inheritance: Phenotypic Transmission from Parents to Children (a Theory of the Effect of Parental Phenotypes on Children's Phenotypes)." *American Journal of Human Genetics* 25 (1973): 618-37.

Csibra, Gergely, and György Gergely. "Natural Pedagogy as an Evolutionary Adaptation." *Philosophical Transactions of the Royal Society B* 366 (2011): 1149-57.

Darwin, Charles. *The Descent of Man and Selection in Relation to Sex*. 2nd ed. 2 vols New York: American Home Library, 1874. 1902.

Dean, L. G., R. L. Kendal, S. J. Schapiro, B. Thierry, and K. N. Laland. "Identification of the Social and Cognitive Processes Underlying Human Cumulative Culture." *Science* 335, no. 6072 (March 2, 2012 2012): 1114-18.

Giddens, Anthony. *New Rules of Sociological Method*. Stanford: Stanford University Press, 1976.

Hamilton, William D. "Genetic Evolution of Social Behavior I, Ii." *Journal of Theoretical Biology* 7, no. 1 (1964): 1-52.

Henrich, Natalie, and Joseph Henrich. *Why Humans Cooperate: A Cultural and Evolutionary Explanation*. Oxford: Oxford University Press, 2007.

Horkheimer, Max. *Critical Theory*. New York: Herder and Herder, 1972.

Laland, Kevin N., John Odling-Smee, and Sean Myles. "How Culture Shaped the Human Genome: Bringing Genetics and the Human Sciences Together." *Nature Reviews Genetics* 11, no. 2 (2010): 137-48.

Leijonhufvud, Axel. "Models and Theories." *Journal of Economic Methodology* 4, no. 2 (1997/12/01 1997): 193-98.

Lewis, H S. "Boas, Darwin, Science, and Anthropology.". *Current Anthropology* 42 (2001): 381-406.
Lumsden, Charles J., and Edward O. Wilson. *Genes, Mind, and Culture: The Coevolutionary Process*. Cambridge, MA: Harvard University Press, 1981.
Lyotard, Jean-Francois. *La Condition Postmoderne: Rapport Sur Le Savoir*. Les Editions de Minuit, 1979.
Mayr, Ernst. *The Growth of Biological Thought*. Cambridge, Massachusetts: Harvard Univ Press, 1982.
Mesoudi, Alex. *Cultural Evolution: How Darwinian Theory Can Explain Human Culture & Synthesize the Social Sciences*. Chicago: University of Chicago Press, 2011.
Miles, Matthew B., and A. Michael. Huberman. *Qualitative Data Analysis*. Thousand Oaks: Sage Publications, 1994.
Netting, Robert M. *Smallholders, Householders: Farm Families and the Ecology of Intensive, Sustainable Agriculture*. Stanford: Stanford University Press, 1993.
Oevermann, U., T. Allert, E. Konau, and J. Krambeck. "Structures of Meaning and Objective Hermeneutics." *A: MEJA, V* (1987).
Pinker, Steven. "The Cognitive Niche: Coevolution of Intelligence, Sociality, and Language." *Proceedings of the National Academy of Sciences* 107, no. Supplement 2 (May 11, 2010 2010): 8993-99.
Richerson, Peter, and Joseph Henrich. "Tribal Social Instincts and the Cultural Evolution of Institutions to Solve Collective Action Problems." *Cliodynamics: the Journal of Theoretical and Mathematical History* 3 (2012): 38-80.
Richerson, Peter J., Ryan Baldini, Bret Beheim, Adrian Bell, Katherine Demps, Karl Frost, Vicken Hillis, *et al.* "The Evidence for Selection on Inter-Group Cultural Variation in Humans." (in preparation).
Richerson, Peter J., Robert L. Bettinger, and Robert Boyd. "Evolution on a Restless Planet: Were Environmental Variability and Environmental Change Major Drivers of Human Evolution?". In *Handbook of Evolution: Evolution of Living Systems (Including Hominids)*, edited by Franz M. Wuketits and Francisco J. Ayala. 223-42. Weinheim: Wiley-VCH, 2005.
Richerson, Peter J., and Robert Boyd. "Gene-Culture Coevolution in the Age of Genomics." *Proceedings National Academy of Science USA* 107, no. Supplement 2 (2010): 8985-92.
———. *Not by Genes Alone: How Culture Transformed Human Evolution*. Chicago: University of Chicago Press, 2005.
———. "Simple Models of Complex Phenomena: The Case of Cultural Evolution." In *The Latest on the Best: Essays on Evolution and Optimality*, edited by John Dupré. 27-52. Cambridge: MIT Press, 1987.
Steward, J. H. *Theory of Culture Change*. University of Illinois Press, 1955.
Taleb, Nasim. "The Fourth Quadrant: A Map of the Limits of Statistics." In, *The Edge* (2008): 1-19.
Tennie, Claudio, Josep Call, and Michael Tomasello. "Ratcheting up the Ratchet: On the Evolution of Cumulative Culture." *Philosophical Transactions of the Royal Society B: Biological Sciences* 364, no. 1528 (August 27, 2009 2009): 2405-15.
Tomasello, M., M. Carpenter, J. Call, T. Behne, and H. Moll. "Understanding and Sharing Intentions: The Origins of Cultural Cognition." [In eng]. *Behavioral and Brain Sciences* 28, no. 5 (Oct 2005): 675-91.

Tooby, John, and Leda Cosmides. "The Psychological Foundations of Culture." In *The Adapted Mind: Evolutionary Psychology and the Generation of Culture*, edited by Jerome Barkow, Leda Cosmides and John Tooby. 19-136. New York: Oxford University Press, 1992.

Walters, Carl J., and C. S. Holling. "Large-Scale Management Experiments and Learning by Doing." *Ecology* 71, no. 6 (1990/12/01 1990): 2060-68.

Watkins, J.W.N. "Historical Explanation in the Social Sciences." *British Journal for the Philosophy of Science* (1957).

Weber, Max. *Economy and Society*. Berkeley: University of California Press, 1922.

Whitehead, Hal, and Peter J. Richerson. "The Evolution of Conformist Social Learning Can Cause Population Collapse in Realistically Variable Environments." *Evolution and Human Behavior* 30 (2009): 261-73.

Whiten, A., J. Goodall, W. C. McGrew, T. Nishida, V. Reynolds, Y. Sugiyama, C. E. G. Tutin, R. W. Wrangham, and C. Boesch. "Cultures in Chimpanzees." *Nature* 399, no. 17 June (1999 1999): 682-85.

Wilson, Edward O. *Consilience: The Unity of Knowledge*. New York: Knopf, 1998.