introduced the concept of imitating the successful and one of its subtypes, the imitation of those with prestige. But prestige is itself a complex social construction. Some prestige derives from personal charisma, some from institutionalized office. Some kinds of prestige may be recognized by nearly everyone in a society, whereas other forms may be highly local. We have no idea how many distinct varieties of prestige-based selective imitation there might be. We have little doubt that cultural evolution a complex and diverse set of phenomena, though we can only dimly imagine complexity from our present vantage point.

The quantitative roles of the various forces in concrete cases of evolution are scarcely known. In selecting studies to include in this book to illustrate the processes of cultural evolution, we have usually been reduced to examples where a single process, such as natural selection or one of the decision-making forces, is arguably dominant. In general, several forces are liable to simultaneously affect the evolution of any given bit of culture we choose to focus on. For example, innate, learned, and culturally acquired dispositions, often acting in different directions, are liable to simultaneously affect whether certain religious beliefs or innovations increase or decrease in frequency. Much of evolutionary science can be boiled down to estimating the strength of various effects on the trajectory of evolution in a sufficiently large number of cases to obtain some empirical generalizations. The gold-standard study of organic evolution is one in which the investigator estimates the strength of natural selection and other forces in an evolving population.[27] In the case of culture, such studies are still very few.[28]

Conclusion: Nothing about culture makes sense except in the light of evolution

In 1982, the pioneering evolutionary economists Richard Nelson and Sidney Winter remarked that among the interesting intellectual challenges in their discipline, "certainly none is more worthy of attention than that of understanding the great complex of cumulative change in technology and economic organization that has transformed the human situation in the last few centuries."[29] Historians and sociologists would nominate the rise of complex societies beginning five millennia ago and their subsequent development as another paramount question. Anthropologists would nominate the origins of agriculture eleven millennia ago and paleoanthropologists the origins of modern humans that culminated with the first complex

cultural systems some one hundred or more millennia ago. At the other end of the spectrum, political scientists would nominate the emergence of new political institutions and public policies, and how these rule systems affect political and economic development on the timescale of a few election cycles. What contemporary humans *are* is a product of such past and ongoing evolutionary events.

Evolutionary processes are thus at the crux of the most interesting questions about our species. How do we find ourselves in the early twenty-first century in the particular state we are in? The cultural evolutionary events of the centuries that came before have everything to do with that. Why do we have the social predispositions that we do? The coevolution of genes and culture over a million or more years has much to do with that. Can we influence the current evolution of human societies in desirable directions? As humans, we are unusually active agents in our own evolution, because we each choose which cultural variants to adopt and which to neglect.[30] Moreover, we organize institutions ranging from a simple tribal council to highly complex modern ones, such as the research university and the political party, that are designed to direct the course of cultural evolution.[31] Yet, cultural evolution is a very big dog on the end of our leash. Even cultural heroes leading great political movements typically have modest effects. Gandhi could not prevent the Muslims from leaving India, nor could he persuade Hindus to reform the caste system. Only by attending properly to the population-level processes can we arrive at a proper picture of cultural evolution. With a reasonable picture of cultural evolution in hand, we could begin to understand how we might humanize processes that often exact savage costs in the currency of human misery.

In this book, we have made the case for using Darwinian methods to understand cultural evolution. Culture is stored in populations, so understanding human brains and how populations change requires population thinking. Darwinian accounts are one part bookkeeping—a quantitative description of cultural variation and its change through time. In addition, they are one part quantitative budget analysis—a systematic attribution of changes to causal processes. If you are going to study cultural evolution in a serious way, you are going to be driven to Darwinian methods of analysis. You have to be able to describe change and you have to be able to account for change. Several research programs in social sciences have independently converged on the Darwinian methods. The sociolinguists' microevolutionary studies of dialect evolution are a particularly sophisticated example; elsewhere we note others.[32]

Our own particular analyses may be maladroit. Borrowing tools from biology and remodeling them for culture has the attraction of capitalizing on the sophistication of evolutionary biology, but it may well introduce distortions. What is more, we have just argued that the Darwinian work to date is at best seriously incomplete. We make no apology for this. Science is an error prone, one-step-at-a-time procedure, and the story shall remain incomplete for a long time if not forever.[33] The only thing about the project that we care to assert with utter conviction is that the Darwinian approach is *worth pursuing.*[34] Those who engage in the pursuit will take proper delight in remedying our generation's errors and omissions!

Much of the objection to applying Darwinian tools to the human case seems to come from a visceral dislike of picturing us as just "another unique species."[35] From the evolutionist's point of view, human exceptionalism is a major problem. As long as humans stand outside the Darwinian synthesis, as long as human culture is said to be superorganic, the whole Darwinian project has a potentially fatal gap. Darwin feared that attacks on the *Descent of Man* would be used as a platform for attacks on the whole edifice of his theory. In this he was not disappointed. As the *Quarterly Review*'s commentator, probably the long hostile and devoutly Catholic St. George Mivart, gloated, the *Descent* "offers a good opportunity for reviewing his whole position" (and rejecting it).[36] The modern secular Science Wars critics evolved from the superorganic version of human exceptionalism that we critiqued in chapter 1, and their objection to science being applied to humans has generally come to be accompanied by a hostility toward science in general. Of course, the religious version persists, too, in fundamentalist circles. Doc Watson sings, "Man came from monkey, so some folks say, but the Good Book don't quite tell it that way. If you believe the monkey business, some people do, then I'd rather be that monkey's brother than you."[37] If humans are outside the bounds of science, then no doubt other things are, too. Science is *bound by its charter* to pursue explanations of human evolution!

Darwinians generally feel more bemused than beleaguered by their critics. Scientists very commonly have humanistic interests. They paint, read novels, write history. So many older scientists try their hand at philosophy that it can practically be regarded as a normal sign of aging. Many are politically active. On the religious side, most scientists will admit to a belief in a god if a sufficiently broad definition is used.[38] Far from feeling a conflict between their science, their religion, and their humanistic impulses, most scientists find their science suffused with the beautiful and the sublime.[39]

Darwin ended *On the Origin of Species* with a lyrical paragraph reading in part as follows:

> It is interesting to contemplate an entangled bank, clothed with many plants of many kinds, with birds singing on the bushes, with various insects flitting about, and with worms crawling through the damp earth, and to reflect that these elaborately constructed forms, so different from each other in so complex a manner, have all been produced by laws acting around us. . . . There is grandeur in this view of life, with its several powers, having originally breathed into a few forms or into one; and that, whilst this planet has gone on cycling on according to the fixed law of gravity, from so simple a beginning endless forms most beautiful and most wonderful have been, and are being, evolved.

Scientific methods are a lot like Zen meditation—arduous and exacting practices that allow the practitioner to win some lovely, if fragile and fallible, truths, eyeball to eyeball with the great mystery. Scratch many a scientist, and a nature mystic bleeds. We feel so about our subject. Peoples and their cultures are wondrous and diverse. The study of human diversity highlights how much humanity we share with the most exotic of our fellows. Darwin believed that anyone whose heart had not been hardened by some specious ideology would feel sympathy for the sufferings of any other human. His description of his feelings about slavery, aroused by his experience of Brazil's treatment of slaves, is the most passionate passage he ever wrote.[40] On the other hand, cultural differences are profound and profoundly interesting. We don't subscribe to an extreme form of cultural relativism (Nazism, after all, was not quaint German folklore). However, the anthropologists' practice of refusing the easy pleasures of ethnocentrism in favor of reserving judgment about other societies—at least until you understand them well—has much to recommend it. Stubbornly anachronistic peoples such as the Anabaptists and the Nuer command respect—even admiration. Though few of us would care to join such societies, we can understand why those brought up in them are proud and successful human beings.

Mathematical models are, as we have said, deliberately shorn of all the rich detail that makes people themselves so interesting. Foolish indeed are the mathematical modelers who confuse their abstractions with reality. But when used properly, mathematics schools our intuition in ways that no other technique can. It is a form of meditation upon nature without peer.

We are constantly struck by the way our naive intuitions are confounded and then rebuilt along new lines by the results of models. Bit by bit, models can be used to dissect the logic of complex systems. The sharp contrast between the difficulty of making good models and their manifest simplicity compared to the phenomena they seek to understand is a humbling, even spiritual, experience. We followed the development of adding social learning to individual learning in simple evolutionary models in chapter 4. We saw that Alan Rogers's very simple model in which social learning evolved without being adaptive led to some real insights into exactly what properties are needed for culture to be adaptive. Good models produce diamond-clear deductive insights into the logic of evolutionary processes. The aesthetic dimension of models is something their critics, unfortunately, never experience. Modelers love a well-designed, well-analyzed representation, as with other artifacts whose beauty lies in their elegant minimalist functionality. We experience when teaching how taking up a nice, old model after a length of time brings on a nice, warm feeling. When it comes to subject areas like evolution, you cannot think straight without them, just like you can't hike for long over rough ground without a good pair of boots. You don't have to *be* a modeler to appreciate models. Much like in any other art form, educated connoisseurs can get a lot out of them.

A good set of data also is a beautiful thing to behold. Foolish, of course, is the empiricist who thinks that even the most beautiful set of data captures any complex phenomenon completely, especially one who thinks that the data from his own case applies without exception to a diverse system such as human culture.[41] However, data are the ultimate arbiter. More than just testing hypotheses, data often start us thinking in the first place. The great pioneer of mathematical population genetics, J. B. S. Haldane, said, "the world is not only queerer than we suppose, but queerer than we can suppose."[42] In chapter 2, we reviewed beautiful studies documenting the existence of cultural variation. Many scholars poke fun at cultural explanations for their supposed lack of sophistication, and argue cogently that innate information, rational calculation, and ecological variation are quite plausible alternatives to cultural explanations. In any given case, perhaps such alternatives are correct, but as general arguments against culture, the empirical data are clear enough. Cultural scientists have developed a considerable body of elegantly compelling, even if largely qualitative, data. The importance of cultural variation in the human species is hardly more dubious than role of gravity in the motions of the planets. As with models, the empirical picture gets built bit by bit, gradually constraining the range of plausible explanations with ever better data.

Some data are so sublime they completely transform our picture of the world in a most surprising way. Data from ice and ocean cores collected over the last decade document the extreme variability of climate during the last ice age, giving us a stunningly surprising picture of the sort of world in which our cultural system arose. We barely dared to imagine that such data would come to light, even though our models suggested that such variability is a plausible engine driving the evolution of our capacities for culture. More surprises in both past and future climates are virtually a certainty.[43] The world is so complex that without sound empirical data the theorists are blind. Those who claim to study unquantifiable complexity are being unreasonable, for quantifying is precisely what we do when things get complicated.

With that thought, we rest our case.