Adaptation for Culture

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Abstract

The evolutionary study of human behavior has expanded into a broad spectrum of theories and models seeking to explain how genetic evolution enables the development of human culture, how cultural evolution influences biological and psychological evolution, and investigating the ways these processes interact. While natural selection and other genetic mechanisms determined the human ability to create culture, cultural practices can also affect the human genome. Researchers in a variety of social science disciplines are also investigating the root causes of behavioral traits in order to more effectively guide future adaptation to the current global environment. This essay briefly outlines the foundational research on the development of sociobiological disciplines and outlines the application of evolutionary research to current social problems from adapting to climate change and other environmental stressors to altering maladaptive behaviors such as bullying or obesity. It also proposes key issues for future research, highlighting the need for rigorous empirical study and using interdisciplinary teams to create a more robust understanding of the influence culture has on our genes, and vice versa. Collaborative research by a multidisciplinary team of geneticists, behavioral psychologists, anthropologists, and biologists would provide a robust theoretical framework with multiple avenues for study to understand why and how behavioral traits exist. This knowledge can then be used to establish more effective policies to improve health and safety.

INTRODUCTION

The application of evolutionary theory to the development of human culture has flourished across the social sciences over the past 40 years. Evolution is a dynamic process. Genes have an impact on the evolution of human culture, determining the ability of the human brain to acquire, store, and share knowledge. At the same time, culture affects genetic evolution by influencing gene frequencies in a population. Lactose tolerance in adults is well recognized as an example demonstrating how a cultural practice—drinking raw milk in cattle-rearing cultures—has caused an evolutionary change in the human genome. Biological, or genetic, evolution is a slow, ongoing process where changes in the genetic makeup of a population occur from one generation to the next. Cultural evolution is a far more ephemeral term, having different

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meanings to different disciplines. In the 1950s, Kroeber and Kluckholn (1952) identified 164 different definitions of culture. For our purposes in this essay, *culture* broadly refers to the strategy by which humans adapt to the natural environment. Culture encompasses cognitive, technological, political, social, and economic components that are learned and transmitted to others.

This entry summarizes the development of the field of sociobiology and the various theories attempting to clarify the interaction between biological and cultural evolution. Popular theories of gene–culture coevolution, evolutionary psychology, and human behavioral ecology are described, current applications of evolutionary research are outlined, and possible directions for future research are suggested.

Much of the current research on biological and cultural adaptation is used to determine the root causes of certain behaviors to increase the effectiveness of planning to mitigate modern health risks. Environmental fluctuations, disease transmission, modern diet, high population densities, and rapid cultural change are all factors contributing to the stressors of our modern world. By understanding the forces that motivate humans to act the way they do, more effective policies can be designed to foster human adaptation strategies.

FOUNDATIONAL RESEARCH

Much research has been done on both the biological and cultural evolution of *Homo sapiens* (Bolhuis, Brown, Richardson, & Laland, 2011; Buskes, 2013; Gangestad, 2010; Laland, Odling-Smee, & Myles, 2010; Mesoudi, 2011; Mesoudi, Whiten, & Laland, 2006). While Charles Darwin's *On the Origin of Species* (Darwin, 1859) was successful in demonstrating the fact of evolution in the late nineteenth century, his proposal that natural selection was the mechanism driving the process was less well received. In the 1930s and 1940s, the integration of Mendelian genetics with Darwin's theory of evolution resulted in a neo-Darwinian theory of evolution that recognized the importance of random mutation and variation within a population. This idea, also known as the *modern synthesis* or *modern evolutionary synthesis*, reflected the consensus derived from several biological specialties about the mechanisms that drive evolution. In fact, heritable traits are determined by genes and natural selection and sexual selection are the principal driving forces of evolution. The term was created by Julian Huxley in his book *Evolution: The Modern Synthesis* (1942), which incorporated ideas from genetics, cytology, botany, morphology, ecology, and paleontology, originating both in the field and in the laboratory. The modern synthesis opened researchers to develop models applying the principles of evolutionary theory to the development of human culture.

The discipline of ethology was also founded in the 1930s. A subtopic of zoology, it focuses on the objective and scientific study of animal behavior in its natural habitat. Ethologists typically focus on a particular behavior rather than an individual species—looking at traits such as aggression and altruism across a variety of species. In the 1970s, it was argued that most ethology research focused on individuals, and the term *social ethology* was used to distinguish the behavior of social groups and the social structure within them. Today, there is a spectrum of approaches to the study of behavior, from animal cognition to comparative psychology, ethology, sociobiology, and behavioral ecology.

The discipline of sociobiology can be traced back to the 1940s, but it did not gain widespread recognition until 1975, when Edward O. Wilson popularized the term in his book *Sociobiology: The New Synthesis*. Sociobiology is defined simply as the systematic study of the biological basis of social behavior in organisms. It builds on the foundations of the modern synthesis by adding four key concepts developed by William D. Hamilton and Robert Trivers: inclusive fitness, reciprocal altruism, parental investment, and parent/offspring conflict. These concepts enabled sociobiologists to structure an evolutionary account of social behavior that could be applied to any animal group, relying on natural selection at the individual level (Hamilton, 1964; Trivers, 1971).

The most recent step in Darwinian evolution has been taken by the school of evolutionary psychology—a direct descendant of sociobiology. Contemporary evolutionary psychologists focus their research on understanding the cognitive abilities of the human mind by examining traits such as memory, perception, or language from a modern evolutionary perspective. They attempt to identify which traits are evolved adaptations—products of either natural selection or sexual selection that developed to solve recurrent problems in ancient environments. Evolutionary psychologists propose that universal behaviors seen across all cultures are candidates for evolutionary adaptations, for example, the ability to determine the emotional state of others, cooperation/altruism, aggression, or healthy mate selection.

The study of human behavior and evolution is cluttered with confusing terminology. A brief search will encounter researchers calling themselves Darwinian psychologists, evolutionary anthropologists, gene–culture coevolutionists, culture selectionists, human ecologists, evolutionary psychologists, and more. Methodologies range from evolutionary psychology, human behavioral ecology, dual inheritance theory (DIT), cultural evolution, memetics, social ethology, and sociobiology. Some people consider all these approaches to fall under the human sociobiology umbrella, while others consider them to be distinctly different fields. These different schools often agree on basic points, but differ in emphasis. Some cultural anthropologists

hold the extreme view that cultural evolution has nothing in common with biological evolution, and they are completely separate processes. This position is both theoretically and empirically groundless. Both systems demonstrate the same fundamental processes of variation, selection, and transmission. Other theories and methodologies focus on the level of emphasis between the two, ranging from theories of culture having the greater impact on biological evolution to genetics dominating over cultural evolution.

No researcher believes that biological and cultural evolution are identical in every respect. They are similar, but differ in important ways. For example, one of the key components of evolution is inheritance, or the transmission of genes/information. During the course of biological evolution, genes are passed to the next generation through reproduction—the flow of information is vertical, from parent to offspring. The transmission of culture, on the other hand, can be linear or horizontal. The flow of information might be passed to offspring, contemporaries, or nonrelatives. Although different and much faster than biological evolution, cultural evolution might still be considered "Darwinian" because both are characterized by the accumulation of information, resulting in complex adaptations, being transmitted from one generation to the next. The following methodologies vary in emphasis, focusing on the similarities or on the differences between biological and cultural evolution, but all seem to generally agree that they are "similar, but different." Given the diversity that exists in both types of evolution, it would be easy to find examples to support either argument.

One popular approach to adaptation research is human behavioral ecology. In this field of study, anthropologists attempt to demonstrate that humans alter their behavior to reflect environmental conditions with the goal of maximizing their reproductive success. Mathematical modeling is used to determine which behaviors would maximize fitness under different conditions, then groups of people are studied to see if their behavior matches the predicted outcomes.

Evolutionary psychology is another currently popular approach to study human behavior from an evolutionary perspective, but evolutionary psychologists believe that evolution influenced psychological mechanisms to deal with problems faced in ancient environments, not in current ones. Evolutionary psychologists suggest that behaviors that evolved long ago as beneficial may be maladaptive in our current environment. Another approach to the study of human behavior is memetics. Memes are analogous to genes, or basic units of culture. They can be words, beliefs, or concepts, such as the wheel. The term was coined by Richard Dawkins in his 1976 book, *The Selfish Gene*. Memetics applies evolutionary principles to the replication and spread

of information, making meme transfer the mechanism driving human cultural evolution. Research methodologies that apply the concept of memetics include cultural evolution, social analytics, viral marketing, public relations, and more.

Another approach to adaptation studies is DIT, or gene–culture coevolution. In contrast to other approaches that imply culture overrides biology, DIT postulates that humans are the products of the interaction between biological evolution and cultural evolution. The three main claims of DIT are that cultural capacities are adaptations, culture evolves, and genes and culture coevolve. Peter Richardson and Robert Boyd published a book in 1985, *Culture and the Evolutionary Process*, arguing that biological evolution produced the capacity for culture in humans and culture began to evolve through natural selection. At the same time, the process of natural selection acting on cultural variants impacted the biological evolution of humans. A well-known example of this interaction is the coevolution of the cultural practice of dairy herding and the physiological evolution of genes allowing humans to digest milk beyond the age of weaning in cultures having a long herding tradition. The 1985 publication contained extensive mathematical models, challenging for the average reader to absorb. The authors wrote a more approachable framework of DIT in 2006 titled *Not by Genes Alone: How Culture Transformed Human Evolution* to update their model and make it more accessible to the nonspecialist. DIT is a promising field due to its scientific rigor. It could potentially be combined with other approaches to develop an integrated theoretical research framework.

A relatively new development in evolutionary biology that ties into DIT is niche construction theory (NCT). Niche construction is the idea that organisms have the capacity to modify the process of natural selection by making choices and participating in activities that modify their own and each other's environments (Odling-Smee, Laland, & Feldman, 2003). One clear example is beavers constructing a dam that greatly modifies the immediate area by flooding. Animals creating burrows, plants changing the composition of the atmosphere, and organic matter decaying are all examples of niche construction. NCT is gaining momentum due to the development of population genetics theory, which has demonstrated that niche construction does have an impact on evolutionary outcomes. This new perspective adds a third inheritance to DIT and brings a fresh perspective and exposes new lines of empirical research.

CUTTING EDGE RESEARCH

Regardless of the model, school of thought, or conceptual framework favored by modern anthropological researchers, there are numerous applications for

empirical data gathered on adaptation, genetic evolution, and cultural evolution.

Despite arguments about the science, causes, or timing of climate change, there is nearly unanimous consensus that it is happening. There has been a recent flood of studies from agencies and research institutes around the world investigating human adaptation in the face of impending climate change. The environment has changed rapidly during the evolution of *H. sapiens*. A key to survival has been the ability to imitate and learn from each other. Boyd and Richardson have argued that with the rapid changes in past environments, individuals could not have survived without sharing and building on accumulated knowledge. There was no use in waiting for evolutionary adaptations to occur—there simply has not been enough time. The breakneck pace of cultural evolution allowed modern humans to flourish.

More empirical research on vulnerability, sensitivity, resilience, stress, and adaptive capacity at the group and individual level would provide valuable data for agencies creating policies and predicting risks. The psychological and cognitive aspects of human adaptation to climate change involve coping with increasing climate variability—heat waves, droughts, wild fires, floods, more intense and frequent storms, and disease outbreaks and related stressors. Regional populations generally adapt to the prevailing climatic conditions with behavioral, cultural, and technological responses. Extreme and more frequent weather events are likely to stress populations beyond their adaptation limits. Understanding the impact and health consequences of climate change on human populations will enable global agencies to derive policies that alleviate some of the risks to human health in the (relatively) near future.

Another area of cutting edge research involves determining if behavioral traits are adaptive and finding ways to alter "bad" behavior in modern populations. Evolutionary psychologists, especially, are looking at the evolutionary roots of socially problematic behavior. By understanding *why* certain behaviors have evolved, new strategies and policies can be developed to optimize methods of mitigating these social problems (Tybur & Griskevicius, 2012). Traits evolved in humans to cope with our ancestral environment in ways that are unnecessary today. Behaviors evolved to benefit the individual, not the group as a whole. Traits that optimized survival: the ability to find food, evade predators, find a mate and reproduce, altruism (including cooperation and reciprocity), achieving status in the group, and avoiding disease were challenges requiring different psychological developments in the brain. Individuals with these survival skills produced viable offspring and passed the knowledge and ability to the next generations.

Aggression is one behavior studied extensively today in this context. While it likely evolved to compete against rivals for a mate or to gain status in the social group, aggression can produce maladaptive behavior in modern society. For example, bullying is a form of aggression that has been observed in every society researchers have examined (Volk, Camilleri, Dane, & Marini, 2012). Zero-tolerance policies have been widely adopted as a response, requiring bullies stop the behavior without understanding why they act that way. Zero-tolerance policies, however, are ineffective. Bullies will not stop participating in a behavior that works because authorities tell them to stop. Using an evolutionary perspective, a more effective intervention could involve a policy that rewards prosocial behavior, such as rewarding a dominant teen who stands up for a bullied peer.

Another example of behavior currently under investigation involves eating and diet. In ancient environments, seeking nutrition was labor intensive. We evolved to enjoy the taste of fats and sugars because they provided the most calorie-dense sustenance, and avoid foods that generate disgust (spoiled meat). When food was scarce and difficult to store, this was a valuable trait. Today, this behavior is maladaptive, leading to overeating and poor health. This evolved trait will be difficult to change simply by telling people to eat healthy food. An evolutionary approach may instead suggest changing the taste of food to cater to evolutionary preferences without altering the nutritional value. Understanding the purpose underlying evolutionary behavioral adaptations may lead to more effective planning for our rapidly changing global culture.

KEY ISSUES FOR FUTURE RESEARCH

One key component of future adaptation research will be conducting empirical investigations and gathering evidence. Models, conceptual frameworks, and theories abound in the sociobiology disciplines. However, researchers repeatedly comment on the need for empirical data to support them. Methodological rigor in the study of human traits from an evolutionary perspective; how and why they evolved, which traits are actually mapped onto cognitive mechanisms, and how can this knowledge be applied to improvements in today's society are all questions generating innovative inquiry among adaptation researchers.

Human adaptation for culture encompasses both biological and cultural evolution and the interactions between them. The concept necessarily encompasses biological, anthropological, ecological, and behavioral points of view working in tandem. Interdisciplinary research will be crucial for this reason. Historically, human adaptation research has been conducted in a variety of distinct disciplines or subfields, each standing alone. There

has been progress in integrating approaches and sharing research in recent years, but there is much work to be done (Bolhuis *et al*., 2011). Collaborative efforts by interdisciplinary teams of biologists, geneticists, behavioral psychologists, anthropologists, sociologists, and more will provide a greater pool of knowledge and research methodologies. Different approaches favor different, but potentially complementary, methods to test hypotheses and gather or analyze data. Surveys and questionnaires are subject to bias. Observations and lab experiments provide context but are subject to error; for example, small sample size. Mathematical modeling and simulation predict possible outcomes, but tend to oversimplify real-world situations. Using several of these approaches, however, to test one hypothesis would result in a more robust, pluralistic discipline.

Human behavioral adaptation research is relevant in disciplines outside of the traditional fields of anthropology, biology, and ecology. In addition to obvious governmental agencies such as NASA (National Aeronautics and Space Administration), ambitious private companies are already planning for space travel and colonization. There are physiological and psychological challenges in adapting to space travel and interplanetary missions. The study of human cognitive and psychomotor performance within extended periods of weightlessness and exposure to stressors including microgravity, confinement, sleep disturbances, workload, "homesickness" for those not returning to Earth, and radiation exposure will be needed.

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