

Cultural evolutionary theory: How culture evolves and why it matters

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Human cultural traits—behaviors, ideas, and technologies that can be learned from other individuals—can exhibit complex patterns of transmission and evolution, and researchers have developed theoretical models, both verbal and mathematical, to facilitate our understanding of these patterns. Many of the first quantitative models of cultural evolution were modified from existing concepts in theoretical population genetics because cultural evolution has many parallels with, as well as clear differences from, genetic evolution. Furthermore, cultural and genetic evolution can interact with one another and influence both transmission and selection. This interaction requires theoretical treatments of gene–culture coevolution and dual inheritance, in addition to purely cultural evolution. In addition, cultural evolutionary theory is a natural component of studies in demography, human ecology, and many other disciplines. Here, we review the core concepts in cultural evolutionary theory as they pertain to the extension of biology through culture, focusing on cultural evolutionary applications in population genetics, ecology, and demography. For each of these disciplines, we review the theoretical literature and highlight relevant empirical studies. We also discuss the societal implications of the study of cultural evolution and of the interactions of humans with one another and with their environment.

cultural evolution | mathematical models | gene–culture coevolution | niche construction | demography

Human culture encompasses ideas, behaviors, and artifacts that can be learned and transmitted between individuals and can change over time (1). This process of transmission and change is reminiscent of Darwin's principle of descent with modification through natural selection, and Darwin himself drew this explicit link in the case of languages: "The formation of different languages and of distinct species, and the proofs that both have been developed through a gradual process, are curiously parallel" (2, 3). Theory underpins most scientific endeavors, and, in the 1970s, researchers began to lay the groundwork for cultural evolutionary theory, building on the neo-Darwinian synthesis of genetics and evolution by using verbal, diagrammatic, and mathematical models (4–8). These models are, by necessity, approximations of reality (9), but because they require researchers to specify their assumptions and extract the most important features from complex processes, they have proven exceedingly useful in advancing the study of cultural evolution (10). Here, we review the field of cultural evolutionary theory as it pertains to the extension of biology through culture. We focus on human culture because the bulk of cultural evolutionary models are human-centric and certain processes such as cumulative culture seem to be unique to humans. However, numerous nonhuman species also exhibit cultural transmission, and we consider the areas of overlap between models of human and animal culture in *Discussion*.

The study of cultural evolution is important beyond its academic value. Cultural evolution is a fundamentally interdisciplinary field, bridging gaps between academic disciplines and facilitating connections between disparate approaches. For example, the advent of technologies for revealing genomic variation has led to a plethora of studies that measure associations

between DNA variants and traits that have major cultural components, such as years of schooling, marriage choices, IQ test results, and poverty. Perhaps because of the perceived greater precision of the genomic data, these culturally transmitted components have been relegated to the deep background, creating a misleading public portrayal of the traits as being predetermined by genetics (see, e.g., ref. 11). Models of the dynamics of interaction among culture, demography, and genetics, which uncover the complexities in the determination of these behaviors and traits, are crucial to remedy this potentially dangerous misinterpretation.

Here, we explore the ways in which cultural evolutionary theory and its applications enhance our understanding of human history and human biology, focusing on the links between cultural evolutionary theory and population genetics, human behavioral ecology, and demography. Throughout, we give examples of efforts to apply theory to data, linking models of cultural evolution to empirical studies of genetics, language, archaeology, and anthropology. For example, studies of cultural factors, including language and customs, help biologists interpret patterns of genetic evolution that might be misinterpreted if the cultural context were not taken into account. Finally, we outline several societal implications of cultural evolutionary theory.

Population Genetics and Cultural Evolution

Many of the first models of cultural evolution drew explicit parallels between culture and genes by modifying concepts from theoretical population genetics and applying them to culture. Cultural patterns of transmission, innovation, random fluctuations, and selection are conceptually analogous to genetic processes of transmission, mutation, drift, and selection, and many of the mathematical techniques used to study genetics can be useful in the study of culture (1, 12). However, these mathematical approaches had to be modified to account for the differences between genetic and cultural transmission. For example, we do not expect cultural transmission to follow the rules of genetic transmission strictly. Indeed, cultural traits are likely to deviate from all three laws of Mendelian inheritance: segregation, independent assortment, and dominance (13).

The simple observation that cultural traits need not conform to Mendelian inheritance is sufficient to produce complex evolutionary dynamics: If children are likely to reject a cultural trait that both of their parents possess, the frequency of that trait in the population may oscillate between generations (4). In addition, if two biological parents have different forms of a cultural trait, their child is not necessarily equally likely to acquire the

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Culture Evolves Culture Evolves:

Decoding **Culture Evolves Culture Evolves**: Revealing the Captivating Potential of Verbal Expression

In an era characterized by interconnectedness and an insatiable thirst for knowledge, the captivating potential of verbal expression has emerged as a formidable force. Its ability to evoke sentiments, stimulate introspection, and incite profound transformations is genuinely awe-inspiring. Within the pages of "**Culture Evolves Culture Evolves**," a mesmerizing literary creation penned by way of a celebrated wordsmith, readers embark on an enlightening odyssey, unraveling the intricate significance of language and its enduring effect on our lives. In this appraisal, we shall explore the book's central themes, evaluate its distinctive writing style, and gauge its pervasive influence on the hearts and minds of its readership.

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