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Review Article

A field guide for teaching evolution in the social sciences

Cristine H. Legare [a], John E. Opfer [b], Justin T.A. Busch [a], Andrew Shtulman [c]

[a] The University of Texas at Austin, United States
[b] The Ohio State University, United States
[c] Occidental College, United States

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ABSTRACT

The theory of evolution by natural selection has begun to revolutionize our understanding of perception, cognition, language, social behavior, and cultural practices. Despite the centrality of evolutionary theory to the social sciences, many students, teachers, and even scientists struggle to understand how natural selection works. Our goal is to provide a field guide for social scientists on teaching evolution, based on research in cognitive psychology, developmental psychology, and education. We synthesize what is known about the psychological obstacles to understanding evolution, methods for assessing evolution understanding, and pedagogical strategies for improving evolution understanding. We review what is known about teaching evolution about nonhuman species and then explore implications of these findings for the teaching of evolution about humans. By leveraging our knowledge of how to teach evolution in general, we hope to motivate and equip social scientists to begin teaching evolution in the context of their own field.

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E-mail address: legare@austin.utexas.edu (C.H. Legare).

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1. A field guide for teaching evolution

Social scientists are increasingly adopting an evolutionary perspective in how they study and describe human cognition and behavior (Boyd & Silk, 2015; Lewis, Al-Shawaf, Conroy-Beam, Asao, & Buss, 2017). The ability to teach evolution effectively should not be taken for granted. One reason is that few social science educators have deep knowledge of evolutionary biology. To our knowledge, Ph.D. programs in social science do not (yet) require coursework in evolution. Another reason is that evolution by natural selection is one of the most difficult scientific concepts for students to grasp (Rosengren, Brem, Evans, & Sinatra, 2012). Decades of research in cognitive psychology, developmental psychology, and science education have revealed that students regularly misunderstand what evolution is and how it occurs (Bean, Sinatra, & Schrader, 2010; Short & Hawley, 2014; Shtulman & Calabi, 2013; Shtulman & Schulz, 2008; Sinatra, Brem, & Evans, 2008; Sinatra, Southerland, McConaughy, & Demastes, 2003). Misunderstandings about the logic of evolutionary theory are rampant, which makes teaching it more difficult. For example, individuals who lack an understanding of evolution are less likely to accept it (Weisberg, Landrum, Metz, & Weisberg, in press). The objective of this paper is to provide social scientists with a field guide for teaching evolution. We synthesize what is known about the psychological obstacles to understanding evolution, methods for assessing evolution understanding, and pedagogical strategies for improving evolution understanding, with an eye toward informing the social science curriculum.

The field of evolutionary social science is quickly advancing, providing a more nuanced understanding of human cognition and behavior (Barrett, 2015; Bolhuis, Brown, Richardson, & Laland, 2011; Buss, 2015, 2016; Henrich, 2016; Wilson, 2007, 2015). We argue that integrating evolution more fully into the social science curriculum is long overdue. Our goal is to spur that integration by providing social scientists with a field guide on research on teaching evolution. First, we discuss obstacles to understanding evolution proper and then discuss how those obstacles might affect understanding the evolution of human cognition and behavior. Next, we discuss assessment of students' understanding and misunderstanding of evolution, as well as the possibility of adapting those assessments for use in the social sciences. Finally, we describe pedagogical techniques for teaching evolution in general and consider their strengths and weaknesses for teaching evolutionary social science. By leveraging our knowledge of how evolution can be taught successfully in a biological context, we hope to motivate and equip social scientists to begin teaching evolution in the context of their own field, addressing pedagogical questions specific to evolutionary social science along the way.

2. Obstacles to understanding evolution

Scientists overwhelmingly support the theory of evolution, with 98% agreeing that humans evolved over time whereas only 62% of the general U.S. population agrees with such a statement (Pew Research Center, 2014). The challenges associated with understanding evolution by natural selection are not exclusively the result of substantial popular resistance to scientific ideas on religious or other ideological grounds (Bloom & Skolnick Weisberg, 2007; Brem, Ranney, & Schindel, 2003; Evans, 2000a; Lombrozo, Shtulman, & Weisberg, 2006; Scott, 2004). Indeed, research shows that cultural factors such as religion and parental attitudes do not predict students' learning of natural selection (Barnes, Evans, Hazel, Brownell, & Nesse, 2017). Here we discuss the cognitive biases that pose substantial obstacles to understanding biological change (Evans, 2000b; Evans & Lane, 2011; Legare, Lane, & Evans, 2012; Shtulman, 2006; Sinatra et al., 2008). Among these are the essentialist tendency to view species as unchanging (Emmons & Kelemen, 2015; Evans, 2000a; Gelman, 2003; Herrmann, French, DeHart, & Rosengren, 2013; Mayr, 1982; Poling & Evans, 2002) and the teleological tendency to explain all kinds of natural phenomena by reference to purpose (Evans, 2001; Keil, 1992; Kelemen, 1999b). We also discuss the existential anxiety invoked by evolutionary theory and its implications fior accepting evolutionary explanations (Brem et al., 2003; Evans, 2000b; Evans, Legare, & Rosengren, 2011; Legare, Evans, Rosengren, & Harris, 2012; Legare & Visala, 2011; Tracy, Hart, & Martens, 2011).

2.1. Essentialism

Psychological essentialism is the belief that the members of a category (e.g., zebras) are united by a common essence, which determines the members' outwardly observable properties (e.g., their stripes, their hooves, their diet) (Gelman, 2003). Essentialist reasoning assumes that categories are stable (zebra babies grow into zebra adults) and immutable (once a zebra, always a zebra; Gelman & Rhodes, 2012, p. 8). Essentialist reasoning is largely incompatible with evolutionary theory. The idea that each species is undergirded by a separate, discrete essence is inconsistent with the idea that all extant life forms share a common ancestor (Mayr, 1982). Essentialist thinking about species likely reflects functional cognitive adaptations. The assumption that species are unchanging underlies many practical inferences in the biological world. Avoiding poisonous snakes or spiders, for example, requires no knowledge that modern snakes evolved from predecessor forms. Viewing them as having unchanging inherent properties that are hazardous to humans facilitates avoiding them. For all practical purposes, they are unchanging essences within human lifespans. Cognitive adaptations evolved to deal with problems that occurred in seconds, minutes, sometimes days, or occasionally months or years. We are less psychologically prepared to understand things that change gradually over hundreds of generations.

Essentialism also results in boundary intensification, which is incompatible with an evolutionary view of life. If species are perceived to be bounded, the relations among species can be difficult to discern, let alone the variation within a species (Shtulman & Schulz, 2008). To further compound the problem, essentialism is consistent with a need-based view of change, in which individual organisms develop traits based on their needs and then pass those traits to their offspring (Gelman & Rhodes, 2012; Ware & Gelman, 2014). It is true that *populations* of individuals do adapt to challenges of survival and reproduction, yet need-based explanations are insufficient for understanding population level variation and selection (Legare, Lane, & Evans, 2013).

2.2. Teleological reasoning

Evolution by selection involves two key components—blind chance variations (mutations), and selection by consequences. The first component is 'blind' in the key sense that it is not forward-looking, as in a watchmaker (or a God) designing something. In his autobiography, Charles Darwin states that he experienced "the extreme difficulty or rather impossibility of conceiving this immense and wonderful