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Cognitive Psychology 52 (2006) 170–194
Cognitive Psychology
www.elsevier.com/locate/cogpsych

Qualitative differences between naïve and scientific theories of evolution

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Accepted 21 October 2005
Available online 6 December 2005

Abstract

Philosophers of biology have long argued that Darwin's theory of evolution was qualitatively different from all earlier theories of evolution. Whereas Darwin's predecessors and contemporaries explained adaptation as the transformation of a species' "essence," Darwin explained adaptation as the selective propagation of randomly occurring mutations within a population. The present study explored the possibility of a parallel between early "transformational" theories of evolution and modern naïve theories. Forty-two high school and college students and three evolutionary biologists were tested on their understanding of six evolutionary phenomena: variation, inheritance, adaptation, domestication, speciation, and extinction. As predicted, a plurality of participants demonstrated transformational reasoning inconsistent with natural selection. Correlational analyses revealed that participants who demonstrated transformational reasoning were as internally consistent as participants who demonstrated an understanding of natural selection, with the exception of one group of participants who appeared to have assimilated two heuristics—"survival of the fittest" and "acquired traits are not inherited"—into an otherwise transformational framework. These findings suggest that the widespread and early-developing tendency to essentialize biological kinds precludes students from conceptualizing species as populations of individuals differentially affected by the environment.

Keywords: Conceptual development; Conceptual change; Naive theories; Evolution

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doi:10.1016/j.cogpsych.2005.10.001

1. Introduction

The question of why organisms are adapted to the environment in which they live was first formulated by Greek philosophers as early as the seventh century BC (Mayr, 1982), yet it remained unsolved until Darwin published *The Origin of Species* in 1859. Darwin's solution was inspired by three empirical phenomena: (1) superfecundity, or the fact that organisms often produce more offspring than the environment can support, (2) variation, or the fact that offspring are never exact replicas of their parents, and (3) inheritance, or the fact that at least some of this variation is passed down from one generation to the next. From these facts, Darwin inferred the principle of *natural selection*: only those organisms most adapted to the environment will survive to reproduce, thereby increasing the proportion of adaptive traits to non-adaptive traits in future generations of the same species.

Even though Darwin's theory of evolution by natural selection offers a scientific solution to the problems of speciation and species adaptation, it remains a source of controversy and confusion to the public at large. A recent national survey found that only 35% of Americans believe that Darwin's theory of evolution has been well supported by evidence (Newport, 2004). Among Americans with postgraduate degrees, this percentage rises to only 65%. Interestingly, those who do not endorse the claim that Darwin's theory of evolution has been well supported by evidence tend to endorse the alternative claim (i.e., that Darwin's theory of evolution has *not* been well supported by evidence) rather than plead ignorance.

Many biologists have interpreted evolution's lack of popularity and frequent misrepresentation (e.g., as a ladder, chain, or hierarchy) as signs that natural selection is not well understood by the general public. Dawkins (1987), for example, surmises that natural selection is a concept everyone thinks they understand but few actually do. "How can such a powerful idea go still largely unabsorbed into popular consciousness?" he asks. "It is almost as if the human brain were specifically designed to misunderstand Darwinism and to find it hard to believe" (p. xi). Though Dawkins' speculation was most likely made in jest, there is at least one reason to take this speculation seriously: human beings tend to essentialize biological kinds and essentialism is incompatible with natural selection.

To be more specific, a growing body of psychological research suggests that individuals of all ages and cultures assume that a species' outward appearance and behavior are determined by a kind of hidden causal power or "essence" (see Gelman, 2003; Medin & Atran, 2004). Evidence of biological essentialism has been found in children as young as four. Like adults, children of this age believe that species members share both observable and non-observable traits (Gelman & Markman, 1986); that species members possess an innate potential to develop the same traits (Gelman & Wellman, 1991); and that species identity remains constant across both temporary, artificial transformations (Keil, 1989) and permanent, natural transformations (Rosengren, Gelman, Kalish, & McCormick, 1991. Beliefs of this nature have been observed not only in American children but also in Yukatek Maya children (Atran et al., 2001) and Brazilian children (Sousa, Atran, & Medin, 2002). As a framework for understanding the reproduction and inheritance of individual organisms, biological essentialism appears to become entrenched throughout development and is not easily abandoned.

Applied to the study of biological adaptation, essentialism led early evolutionary theorists to commit what Gould (1996) calls the "fallacy of reified variation," or the tendency "to abstract a single ideal or average as the essence of a system and to devalue or ignore variation among the individuals that constitute the full population" (p. 40). These theorists