Book Review

Evolution in Four Dimensions: Genetic, Epigenetic, Behavioral, and Symbolic Variation in the History of Life (Revised Edition). Edited by Eva Jablonka and Marion J. Lamb. 576 pp. Cambridge, MA: MIT Press. 2014. $29.95 (paper), $20.95 (e-book).

In the new edition of *Evolution in Four Dimensions*, Eva Jablonka and Marion Lamb jokingly refer to their endeavor as a "post-Modern…Synthesis" (p. 350), playing on the Modern Synthesis that united natural selection and Mendelian genetics. Here, the authors unite additional dimensions of evolution. However, there are other ways in which this label is also appropriate, as they aim to break down old distinctions, such as the vehicle/replicator distinction put forward in the *Selfish Gene* (Dawkins, 1978), and devote ink to the cultural and political influences on evolutionary thought. In this sense what they propose is a bit like postmodernism, in the dissolution of barriers, an emphasis on holistic thinking, and a critical appraisal of certain paradigms. At the same time, this is certainly not a book that rejects science. If anything, it seeks to cast those same cultural influences as amenable to scientific inquiry.

In this revised 2014 edition, Jablonka and Lamb have changed little of the original text published in 2005. They have added footnotes in the main body to improve the experience for e-book readers and fixed a few typos. Most of the new content is contained in a new 79-page chapter, succinctly called "After Nine Years." The present review largely covers the original text before discussing this new addition.

Let me get right to the point: though not without flaws, this is a book that every anthropologist and evolutionary social scientist should read. A search on Google Scholar reveals that the book has 1,328 citations to date, so it certainly has not been ignored. Yet my impression is that its influence is scattered. It has, as it were, trickled in through the cracks. Yet for anthropology in particular the ideas in *Evolution in Four Dimensions* are particularly germane. Even though written by nonanthropologists, it exemplifies the four-field approach and, more importantly, bridges across them. Moreover, it does so with clear writing, quirky illustrations, and in a way that is, for the most part, nonpolemical.

The book is organized into four parts. The first section deals primarily with natural selection and genetic inheritance, beginning with the cultural and political history of Darwinism and Lamarkism leading to the Modern Synthesis. From here they consider the relationship between genotypes and phenotypes, and develop two key ideas: one is that for information to be meaningful, it must be *interpreted* by a *receiver*. Genetic information is meaningless without the cellular machinery to read it and put it to use. The second, related point is that they see networks of genes and their interpreters as the most fruitful units for evolutionary analysis, rather than simply genes alone.

To be clear, this is primarily a proposal about framing, not a dispute over facts. Jablonka and Lamb signal this by arguing with themselves, in the form of dialogs between M.E. (Marion and Eva) and I.M. (*Ipcha Mistabra*, Aramaic for "the opposite conjecture") placed at the end of each chapter. Whether the unit of inheritance is best considered to be a stretch of DNA called a gene, or a network of genes, or something else, is largely a matter of utility and preference.

They end the first section by discussing the idea that the generation of novel genetic variation may not be an entirely random process. Mutation can be "semidirected" by varying mutation rates in response to stressors or by varying mutation rates across the genome, such that mutations are more likely in areas where variation is beneficial. Here Jablonka and Lamb preface something important that becomes a theme: the power and generality of Darwin's theory of natural selection. Too often, we get in the habit of thinking about natural selection solely in terms of genes and forget that Darwin developed the idea with little idea how inheritance might work. Thus, we should remember that the genetic inheritance system, cellular repair (and mutation) mechanisms, and all other aspects of inheritance are themselves the products of and subject to natural selection.

In the second section, Jablonka and Lamb turn the power of natural selection on three additional classes of inheritance systems: epigenetic inheritance systems, behavioral inheritance systems, and what they call symbolic inheritance systems. Epigenetic inheritance systems include not just methylation, chromatin marking, and microRNAs, which most people are familiar with, but lesser known and discussed systems including self-sustaining loops and inheritance through protein or membrane structures. Behavioral inheritance systems include transmission of information through substances, such as food preferences passed through molecules of food, and various forms of social learning and animal traditions. In both of these sections, Jablonka and Lamb show convincingly that cumulative and interesting evolution can occur though inheritance systems other than the genetic system.

What they call symbolic inheritance is really limited to humans. Here, they see language and other forms of symbolic communication as interacting in a network, something like their network of genes. They focus on cultural variation as being not only transmitted, but reconstructed by receivers, in contrast to other approaches viewing culture as memes or the product of evolved mental modules. There are flaws here, but let me continue before addressing them.

The third section of the book attempts to put the pieces together and show how different inheritance systems can interact. Most of what is discussed here is based on the ideas of genetic assimilation and genetic accommodation of traits acquired either epigenetically or behaviorally. Plasticity, such as behavior, allows a phenotype to precede the genotype, buying time for selection. Moreover, epigenetic marks can directly affect mutation rates in genetic sequences.

Finally, the fourth section of the book contains the content added to this revised edition. This section primarily takes the form of a long dialogue, in which M.E. and I.M. discuss recent advances and results related to the topics discussed in the book. Although one long chapter, the information is organized by the chapters to which it relates, making it possible to read a chapter then flip back to the updates for just that section. It is perhaps a credit to the original book that although this new information adds additional examples and maybe a few twists, it does little to alter the overall message. Instead it highlights

that researchers have been very active in the last nine years studying things like lateral gene transfer and epigenetic inheritance.

Though important, well written, and generally thorough, the book (both original and revised) is not without its faults. In putting the dimensions together, Jablonka and Lamb lay the foundation for a more general theory of evolution, without quite being able to suggest what one would look like. But, it is hard to fault them for this one. Our understandings of epigenetics and cultural inheritance are still limited, even with the addition of nine years of work. What Jablonka and Lamb do is point the way forward toward the questions that remain in need of answers.

Another weak spot is in the discussion of humans, which falls largely under the chapter on symbolic inheritance. Jablonka and Lamb go out of their way to show the importance of cultural inheritance on human behavior and in doing so miss opportunities to integrate across their four dimensions of evolution. For example, they paint a narrow and stereotyped image of human "sociobiology" focused too much on modularity and genes. They fail to recognize that through the phenotypic gambit, many evolutionary studies of human behavior are largely agnostic about the actual mechanism of inheritance. Most of these studies are concerned with the evolutionary gene, not the molecular gene (Griffiths and Neumann-Held, 1999). In fact one might argue that the evolutionary gene has more in common with Jablonka and Lamb's concept of a network as a unit of inheritance than it does with the molecular gene, but this point is sadly missing.

Yet these are minor complaints. Overall Jablonka and Lamb are not polemical in their approach and to pay too much attention to these flaws would be to miss the bigger picture, which is about the importance of thinking about evolution independent of any one inheritance system. Although this new edition adds little to the overall picture, it does highlight that knowledge and interest in epigenetics has exploded in the last nine years. The new studies Jablonka and Lamb discuss in their new final chapter provide more details and examples, but they also confirm that the insights from the 2005 edition have held up in light of new discoveries.

LITERATURE CITED

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AARON D. BLACKWELL
Department of Anthropology
University of California, Santa Barbara
Santa Barbara, California