

EvoDevo as Cognitive Psychology

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The editor-in-chief of *Biological Theory* invited me to submit a short paper on the theoretical intersections between evolutionary developmental biology, on the one hand, and behavior and cognition on the other. My first reaction was that I had not thought about such a topic in years. But he had planted the seed (or tweaked the engram) of that relationship. I gradually came to realize that my recent research in the history of evolutionary developmental biology (now called EvoDevo) has produced results that blend in an intriguing way with the research program that began my scholarly career, the history of mid-20th century experimental psychology, and especially the debates between behaviorist and cognitive psychological theories.

The modest insight I will offer here does not concern the current relations between the sciences of biology and psychology, but how we perceive their histories. I will first describe how I came to study the history of EvoDevo and then report on how recent results have taken me back to the beginning.

My early study of psychological debates was centered on the correspondences between substantive psychological theories (behaviorist versus cognitivist) and the scientific methodologies with which they were pursued. Behaviorism was allied with a kind of positivist, operationalist, or phenomenalist methodological approach, and cognitivism with methodological realism. Each theory/methodology pair was internally adapted in the following sense: If scientists applied their substantive psychological theories to their own research behavior, then they would arrive at something very close to the methodology that they started from. This seemed to make theory change highly unlikely. One would have to jettison one's methodology in order to find grounds to accept the alternative theory, but one already had substantive psychological evidence that one's methodology is the only correct procedure. However, it was

clear that theories did change in psychology. The puzzle was how this came about.

At this point in my struggle I became aware of the formal similarities between trial and error learning (the behaviorist law of effect) and natural selection. Psychologists Donald Campbell and B. F. Skinner had independently come to this realization, but its first discoverer was Chauncey Wright, an American philosopher and correspondent of Charles Darwin. Presumably, biologists knew all about natural selection (I thought)—they might be able to help me understand its psychological analogue. I began to study natural selection in the early 1980s and soon learned of the criticisms of the overreliance on natural selection. The alternative to natural selection that was being offered was developmental constraints. Evolutionary biology possessed not only an analogue to trial and error learning, but also an analogue to cognitive psychology in the theory of developmental constraints! Cognitivists insisted that trial and error was mediated by complex internal states that could speed up, slow down, or channel the effects of environmentally mediated learning. Advocates of developmental constraints said the same thing about the operation of natural selection. Embryological development biased the set of “options” that were available to selection. The analogy was not perfect of course (developmental constraints were neither intentional nor representational). But the criticisms of cognition and constraints were very similar. Behaviorists scorned cognitive states as “mentalistic,” while neo-Darwinians scorned bauplans as “idealistic.” This was enough to get me started on two decades of research into the nature and history of what has matured to be EvoDevo.

Fast forward to 2005, and the publication of my book *The Changing Role of the Embryo in Evolutionary Thought: Roots of Evo-Devo*, in which I examine a long history of debates between EvoDevo as a structuralist school of evolutionary studies and functionalist alternatives including neo-Darwinian theory. The structure–function contrast explains a lot, but not everything. For many years I was unable to discern why EvoDevo styles of reasoning were perfectly acceptable in the

19th century but became controversial in the 20th. It is true that neo-Darwinism is functionalist (with natural selection producing adaptation), but that only reiterates the question, how was functionalism able to dominate structuralism? The answer came out of the work of historian Fred Churchill. During the entire 19th century, the concept of heredity was intertwined with embryological development. To explain heredity, one must explain *how parental traits developed in the offspring embryo*. The 20th-century concept of heredity is quite different. Heredity no longer has the job of explaining the development of inherited traits—only of naming which traits *are* inherited (and attributing their inheritance to hypothesized genes). The ontogeny of the traits—the developmental work of genes in the embryo—had nothing to do with heredity in its new meaning. How did this semantic separation between heredity and development take place? It happened with the introduction of the Mendelian-chromosomal theory of heredity by T. H. Morgan and his students. The original documents show that the authors were keenly aware of the methodological crux. They needed to say that genes *cause* traits in adults even though no one knew anything about how genes operate in the embryo. They needed a concept of causation that skips over the unobserved insides of a complex hidden process: phenomenalist causation. The geneticist associates genes with traits on the outside, so to speak, observing correlations of traits in the parent and offspring generations. Embryogenesis is irrelevant to that association, even though embryogenesis creates the traits. The association is called hereditary causation. “In this sense we may say that a particular factor (p) is the cause of pink [eye color], for *we use cause here in the sense in which science always uses this expression*, namely, to mean that a particular system differs from another system only in one special factor” (Morgan et al. 1915, 209; emphasis added). Transmission genetics was constructed upon this sense of cause. Embryology was not. Morgan’s success came not only from his scientific insights, but also from his methodological and semantic flexibility. As an embryologist, 10 years earlier, he had publicly rejected phenomenalist causation in its application to heredity.

The evolutionary synthesis was built upon a framework of population genetics, which in turn was built upon transmission genetics. The synthesis had no particular use for developmental

genetics. In a nutshell, this explains why the theorists most closely associated with the evolutionary synthesis were at odds with the advocates of developmental constraint in the 1980s. The phenomenalist nature of transmission genetics made development irrelevant to heredity, which made it irrelevant to population genetics, which made it irrelevant to the evolutionary synthesis, which led to the constraint debates of the 1980s.

The book *The Mechanism of Mendelian Heredity* by Morgan et al. was published in 1915, and Watson’s “Psychology as the behaviorist views it” was published in 1913. The Copenhagen Interpretation of quantum physics and Vienna Circle philosophy developed in the 1920s. This confluence of phenomenalist interpretations of scientific thought shaped the debates of the 20th century in psychology and biology. I began by studying the consequences of the phenomenalist methodology of behaviorism. A strange echo of that early work resounds in my recent recognition that EvoDevo’s flourishing came about only after biologists had managed to reopen the black box of development—a box constructed by a methodologically similar phenomenism that began only two years after behaviorism’s inauguration. This coincidence even bears contemporary fruit. I am still puzzling over the relationship between mainstream neo-Darwinism and EvoDevo. No EvoDevo-ite denies the importance of natural selection, but very few EvoDevo concepts pay the slightest attention to populations. Recognition of the phenomenalist origins of population genetics offers a possible solution to this conundrum. EvoDevo is a mechanistic theory about the internal dynamics of a complex system. Population genetics is a phenomenal theory about the statistical behavior of assemblages (populations) of such systems. EvoDevo stands to population genetics as the kinetic theory of gases stands to the phenomenal gas laws.

References

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