The Origins and Development of the Idea of Organism-Environment Interaction

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Abstract The idea of organism-environment interaction, at least in its modern form, dates only to the mid-nineteenth century. After sketching the origins of the organism-environment dichotomy in the work of Auguste Comte and Herbert Spencer, I will chart its metaphysical and methodological influence on later scientists and philosophers such as Conwy Lloyd Morgan and John Dewey. In biology and psychology, the environment was seen as a causal agent, highlighting questions of organismic variation and plasticity. In philosophy, organism-environment interaction provided a new foundation for ethics, politics, and scientific inquiry. Thinking about organism-environment interaction became indispensable, for it had restructured our view of the biological and social world.

1 Introduction

That creatures are shaped by the world around them is not news. Several centuries before the Common Era, the Hippocratic author of "Airs, Waters, Places" argued that our forms and habits are affected by the climate, the air we breathe, and the water we drink. For example, the inhabitants of Phasis reportedly had the deepest voices known because they breathed "air which is moist and damp and not clean" (Lloyd 1978, 162). As I will show, however, this concrete notion of various external conditions affecting the health and features of living beings was gradually replaced in the second half of the nineteenth century by the abstract idea of an organism's environment. The new dichotomy of organism and environment proved both useful and portable. By the 1890s, it was already operating as an essential framing device in scientific and philosophical arguments. In biology and psychology, the

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G. Barker et al. (eds.), *Entangled Life*, History, Philosophy and Theory of the Life Sciences 4, DOI 10.1007/978-94-007-7067-6_2,

environment was seen as a causal agent, highlighting questions of organismic variation and plasticity. In philosophy, organism-environment interaction provided a new foundation for ethics, politics, and scientific inquiry. Thinking about organism-environment interaction became indispensable, for it had restructured our view of the biological and social world.

In the first part of the chapter, I will describe the origins of the idea of organism-environment interaction in the work of Auguste Comte and Herbert Spencer. I will then demonstrate how the idea played a central role in late-nineteenth-century debates over the causal factors of evolution—specifically the controversy over August Weismann's account of heredity and the discovery of the so-called "Baldwin Effect." In the third section, I will follow the idea of organism-environment interaction into philosophy: the pragmatist philosopher John Dewey made the relationship between organism and environment the foundation of his new theories of ethics, education, and scientific inquiry. This chapter and those that follow illustrate how an apparently simple idea—that organisms interact with environments—came to have complicated and lasting consequences, from debates in philosophy and the social sciences to theories of niche construction and human evolution.

2 Origins of an Idea[1]

The English word 'environment' was coined in the late 1820s by the Scottish essayist Thomas Carlyle and popularized in the second half of the century by the philosopher Herbert Spencer. But what is so important about a word? It is not as if earlier thinkers had any trouble discussing the influence of external factors on organisms. For example, Buffon wrote the following in his multi-volume *Natural History*: "The temperature of the climate, the quality of food, and the evils of slavery [i.e., domestication]—these are the three causes of change, alteration, and degeneration in animals" (Buffon 1766, 317). Soon after, French naturalists began to employ umbrella terms for these and other factors, the most influential of which were Jean-Baptiste Lamarck's 'circumstances' and Georges Cuvier's 'conditions of existence.' Lamarck used 'circumstances' to refer to climate, temperature, environing media (water, air), habits, movements, actions, etc. (Lamarck 1801, 13, cf. Lamarck 1809, 1:238). Cuvier's *conditions of existence* was a more formal notion based on the fact that "nothing can exist that does not bring together the conditions that make its existence possible" (Cuvier 1817, 1:6). If terms like 'conditions' and 'circumstances' already existed, why use the word 'environment' in the first place? In this section, I will show that the organism-environment dichotomy emerged from philosophical reflection on the nature of life. Its originator, at least in the English-speaking world, was Spencer.

[1] In parts of this section I have drawn on material from Pearce (2010a).

Naturalists in the first third of the nineteenth century, following the work of Carl Linnaeus, Buffon, and Lamarck among others, became more and more interested in the influence of external conditions on organisms. This interest was most pronounced in the proto-ecological writings of Alexander von Humboldt, Augustin de Candolle, and Charles Lyell (see Pearce 2010b, 501–506). The geographical method of Humboldt and Candolle was an attempt to connect specific plants to particular local circumstances. For example, in his "Physical Table of the Equatorial Regions," Humboldt showed how flora vary with altitude, geology, air temperature, the snow line, and the composition and pressure of the atmosphere (Humboldt and Bonpland 1805, 41–42). Candolle, following Humboldt, discussed "the influence of external elements or agents on plants," specifically "the influence of temperature, of light, of water, of the soil, and of the atmosphere" (Candolle 1820, 362). He linked such external influences to Cuvier's notion of conditions of existence: "Specific plants, given their organization, require specific conditions of existence: one cannot live where it does not find a specific quantity of salt water; another where it does not have, at some time of year, some quantity of water or intensity of sunlight, etc." (Ibid., 384). Lyell extended Candolle's work, pointing out that other organisms make up part of the relevant external conditions:

> The stations of different plants and animals depend on a great complication of circumstances,—on an immense variety of relations in the state of the animate and inanimate worlds. Every plant requires a certain climate, soil, and other conditions, and often the aid of many animals, in order to maintain its ground. (Lyell 1832, 140)

Thus naturalists in the early nineteenth century were investigating the influence of external factors—physical and biological—on plants and animals, and employing terms such as 'conditions' and 'circumstances' to refer collectively to such factors.

But though Humboldt and Candolle emphasized the importance of external circumstances, the move to singular terms like '*milieu*' or 'environment'—and to a more explicit organism-environment dyad—was made by philosophers. Spencer's use of the word 'environment' and his emphasis on the organism-environment relationship derived from his reading of the French philosopher Auguste Comte. In the French tradition, the term '*milieu*' (medium) as the counterpart of '*organisme*' was an innovation of the 1830s, although Lamarck had earlier employed the plural '*milieux*' to refer to environing media such as water or air (Canguilhem 1952). In several texts of 1833, for example, the zoologist Étienne Geoffroy Saint-Hilaire linked changes in an organism to changes in its *milieu ambiant*.[2] He claimed that there are two sorts of facts relevant to developing organisms: those belonging to the essence of a type and those involving the intervention of the ambient world. It is

[2]Geoffroy (1833a, 88–89n) quotes Blaise Pascal making a related point. However, this is not an accurate quotation but a loose reading of the earlier thinker's well known remark, "I am very afraid that this nature might itself only be a first custom, just as custom is a second nature" (Pascal 1669, 199; Pascal 1991, 208).

the latter that explain why pears from the same orchard are sometimes large and sweet, sometimes small and sour (Geoffroy Saint-Hilaire 1833b, 68–69; see also 1833a, 89n).

Comte went further in the third volume of his *Course of Positive Philosophy*, making the relationship between organism and *milieu* the basis of his conception of life. He attacked Xavier Bichat's claim that life is simply the set of functions that resist death:

> The profound irrationality of [Bichat's] conception consists above all in its complete elimination of one of the two inseparable elements whose harmony necessarily constitutes the general idea of *life*. This idea supposes, indeed, not only a being so organized as to possess the vital state, but also, no less indispensable, some set of external influences that make possible the achievement of that state. Such harmony between the living being and the corresponding *medium* evidently characterizes the fundamental condition of life. (Comte 1838, 288–289, original emphasis)

Comte's notion of life followed that of the naturalist Henri-Marie Ducrotay de Blainville, whose definition of "organized body" (i.e., organism) included "acting on environing external bodies and being affected by these bodies" (Blainville 1822, xxii; see Comte 1838, 295).[3] Comte, however, labeled the two parts of the dichotomy: he insisted that "the idea of life constantly supposes the necessary correlation of two indispensable elements, an appropriate organism and a suitable medium" (Comte 1838, 301). Attaching a footnote to 'medium,' Comte called it a new expression designating "the total ensemble of external circumstances, of any kind, necessary to the existence of each particular organism" (Ibid., 301n). Hence '*milieu*' was introduced as an abstract singular term to replace plural terms such as 'circumstances' or 'conditions of existence' in the context of a new philosophical account of life.[4]

English followers of Comte appropriated his new dichotomy. The author and critic George Henry Lewes, for example, emphasized in a debate over progress in the fossil record that organisms were "the resultant of two factors—Life and

[3]For more on the connections between Comte, Blainville, and Lamarck, see Petit (1997) and Braunstein (1997).

[4]Related German concepts and terminology would require a history of their own. Thomas Carlyle seems to have originally coined the word 'environment' to translate the German word '*Umgebung*' (Pearce 2010a, 248). Phrases like "*der Organismus und seine Aussenwelt*" were used in medical writings beginning in the early 1800s: e.g., "the reciprocal determination of the organism and its external world" (Kilian 1802, 150). Philosophically inclined physicians such as Johann Christian Reil and Moritz Naumann also employed this *Organismus-Aussenwelt* dichotomy (Reil 1816, 63; Naumann 1821, 349, 1823, 162). Later in the century German translations used both '*Aussenwelt*' and '*Umgebung*' for Spencer's 'environment' (Spencer 1880, 1:294, 365, 1882, 308, 380). The *Organismus-Umgebung* dyad is apparently absent from German texts prior to the reception of Comte and Spencer. The following is one early usage, before Spencer but after Comte: "form and activity, part and whole, organism and environment are in perfect harmony" (Köstlin 1851, 1:352). Peter Sloterdijk (2005) claims that Jakob von Uexküll (1909) invented the concept of environment, ignoring this rich nineteenth century background.

Circumstance" (Lewes 1851, 996).[5] Lewes's serial summary "Comte's Positive Philosophy" likewise claimed that "*organism* and *medium* are the two correlative ideas of life" (Lewes 1852, 666, original emphasis; cf. Lewes 1853, 167). The word 'environment' was first used in a biological context by the social thinker Harriet Martineau as her preferred translation of Comte's '*milieu*.' Phrases like "the reciprocal action of the organism and its environment" thus appear for the first time in Martineau's translation of Comte's course (Comte 1853, 1:401).

Nevertheless, before Spencer got a hold of it, the word 'environment' was still very rare; he made it a central concept in his popular philosophical accounts of biology and psychology, and by the end of the century it was a common term. Having recently befriended Lewes, Spencer read both Lewes's summary and Martineau's translation of Comte in 1852–1853. Spencer shared Comte's interest in demarcating the living and the non-living, and had previously defined 'life' as "*the co-ordination of actions*" (Spencer 1852, 252, original emphasis). In his later *Principles of Psychology*, however, he adopted Comte's position and Martineau's vocabulary: "the changes or processes displayed by a living body, are specially related to the changes or processes in its environment" (Spencer 1855, 368). This special relation, according to Spencer, is one of correspondence and continuous adjustment:

> The life of the organism will be short or long, low or high, according to the extent to which changes in the environment, are met by corresponding changes in the organism. Allowing a margin for perturbations, the life will continue only while the correspondence continues; the completeness of life will be proportionate to the completeness of the correspondence; and the life will be perfect only when the correspondence is perfect. (Ibid., 376)

This progressive language indicates that Spencer's account of the correspondence between organism and environment was also related to the idea of evolution, for life evolves by improving organism-environment correspondence: as life progresses, said Spencer, this correspondence extends in space and time (i.e., organisms can adapt to external causes less frequently encountered) and increases in speciality, generality, and complexity (Ibid., 394–465). Finally, Spencer declared mind and intelligence merely advanced forms of life; thus he argued that "the manifestations of intelligence are universally found to consist in the establishment of correspondences between relations in the organism and relations in the environment" (Ibid., 483). Spencer's organism-environment dichotomy was thus relevant not only to physiology and zoology but also to psychology, sociology, and ethics, as he attempted to show in later works.

The 1855 edition of Spencer's *Principles of Psychology* was not widely read. But with the publication of the first three parts of his System of Synthetic Philosophy—*First Principles* and *Principles of Biology* in the 1860s and the second edition of the *Psychology* in the early 1870s—his ideas became more and more popular, especially

[5]For evidence that Lewes—and not Spencer—wrote this particular article, see Pearce (2010a, 256n17).

in the United States. In 1871, the philosopher-historian John Fiske gave a series of lectures at Harvard on Spencer's evolutionary philosophy that were simultaneously published in *The World*, a New York newspaper (Berman 1961, 79; Nelson 1977; cf. Fiske 1874). The next year, Edward Livingston Youmans founded the magazine *Popular Science Monthly*, which consistently promoted Spencer's views (Spencer 1872; Youmans 1872). By the late 1870s, William James was assigning Spencer's books to his psychology and philosophy classes at Harvard and the young John Dewey was borrowing these same books from his college library in Vermont (James 1988; Feuer 1958). As Spencer's ideas spread, so did his abstract dichotomy of organism and environment. In the next two sections, we will see how the idea of organism-environment interaction framed a series of conceptual discussions in the 1890s—first in biology and then in philosophy.

3 Environment, Plasticity, and Variation

Spencer's *Principles of Psychology* introduced the idea of organism-environment interaction to the English-speaking world. 'Interaction' suggests a mutual influence: the environment affects the organism just as the organism affects the environment. But Spencer talked mostly about just one causal direction: environments modifying organisms. In the fourth section of the chapter, I will show how some philosophers rejected Spencer's account in favor of a more truly interactive view of the organism-environment relationship. But as will become clear in this section, late-nineteenth-century biologists and psychologists focused primarily—as had Spencer—on the environment as an agent of organismal change.

In the late 1880s, Herbert Spencer published a short book entitled *Factors of Organic Evolution*. Spencer emphasized the importance of its topic in the preface, declaring that the question of which casual factors are operative in evolution "demands, beyond all other questions whatever, the attention of scientific men" (Spencer 1887, iv). A few years later, Spencer got his wish: in the 1890s the "factors of evolution" question attracted the attention of a whole variety of scientists and philosophers, becoming the focus of numerous debates, books, and articles. The idea of organism-environment interaction played a key role in these debates, for one of the main points of contention was whether the role of the environment is primarily that of producing or that of preserving variation.

One of the central problems of the factors of evolution debates of the 1890s was the nature and origin of variation. Charles Darwin's first use of the term 'environment'—which appeared only in his last works—shows that the environment was given a kind of causal agency in such discussions:

> In many cases it is most difficult to distinguish between the definite result of changed conditions, and the accumulation through natural selection of indefinite variations which have prove[d] serviceable. If it profited a plant to inhabit a humid instead of an arid station, a fitting change in its constitution might possibly result from the direct action of the environment. (Darwin 1875, 2:281)

This mention of the possible importance of "direct action of the environment" contrasts with Darwin's earlier inclination "to lay very little weight on the direct action of the conditions of life" (Darwin 1859, 134). It is notable that Darwin first speaks of the environment as an important agent in his book *Variation of Animals and Plants under Domestication*: the *Origin of Species* had for the most part placed variation in a black box, whereas *Variation* made it the central theme.

The main player in the debates over the factors of evolution was the German naturalist August Weismann. Darwin, shortly before he died, wrote a prefatory note to a collection of Weismann's early essays. Darwin's words show that the origin of variation was seen as the next big problem in biology:

> Several distinguished naturalists maintain with much confidence that organic beings tend to vary and to rise in the scale, independently of the conditions to which they and their progenitors have been exposed; whilst others maintain that all variation is due to such exposure, though the manner in which the environment acts is as yet quite unknown. At the present time there is hardly any question in biology of more importance than this of the nature and causes of variability. (Weismann 1882, vi)

Variation was an important problem because although most naturalists—even American holdouts—now admitted the fact of evolution, there was much disagreement as to its causes or factors (LeConte 1878, 786–787).[6] For example, the American paleontologist Edward Drinker Cope argued that natural selection is a restrictive but not an originative factor: that is, it rejects variations but does not produce them (Cope 1887, 350–351). Cope was following the Duke of Argyll (among others), who argued that natural selection "gives an explanation, not of the processes by which new Forms first appear, but only of the processes by which, when they have appeared, they become established in the world" (Argyll 1867, 229). Explaining the origin of variation, for Spencer (1887) and Cope (1887), involved determining how the environment could act as a producer of variation and not merely its preserver.

Weismann's essays on heredity, beginning with "On Heredity" in 1883, explicitly attacked the relevance of environment-induced variations to evolution and thus directly contradicted the work of authors such as Spencer, Cope, and Argyll. This new theory of heredity argued that the germ cells that give rise to offspring should "be regarded as something standing opposed to and separate from the entirety of cells composing the body"; a corollary of this claim was that so-called "acquired characters," those caused by the action of the environment during an organism's lifetime, could not be inherited (Weismann 1883, 1885; Moseley 1885, 155). Weismann's theory provoked a storm of criticism, most of which was focused on the problem of variation. George John Romanes for example, following Spencer, argued that mutual co-adaptation of parts within an organism could not be explained

[6]For more on this period in the history of biology, see Bowler (1983), (1988), and Richards (1987, 331–503).

by merely "fortuitous variation" and natural selection; it had to rely on a tendency of those parts to vary together, i.e., on "the inherited effects of use and disuse" (Romanes 1887, 406; cf. Spencer 1887, 12–17).[7]

Romanes (1888) coined the term 'Neo-Darwinian' to describe naturalists such as Weismann who "aim at establishing for natural selection a sole and universal sovereignty which was never claimed for it by Darwin himself." There were certainly people whose views approached this sovereignty claim. Alfred Russell Wallace, for example, wrote the following in his book *Darwinism*: "Whatever other causes have been at work, Natural Selection is supreme . . . . The more we study it the more we are convinced of its overpowering importance" (Wallace 1889, 444). Cope (1889) replied by repeating that selection could not be the whole story: "selection cannot explain the *origin* of anything, although it can and does explain survival of something already originated; and evolution consists in the origin of characters, as well as their survival." Argyll (1889) accused the neo-Darwinians of rejecting "any conception which tends to break down the empire of mere fortuity in the phenomena of variation." Nevertheless, Weismann gained many followers, most notably Edward Bagnall Poulton and other Oxford naturalists. As Grant Allen put it a few years later,

> for a year or two after the appearance of Weismann's memoirs, nothing else was heard of in *Nature* and in the scientific societies. Weismannism became the fashionable creed of the day . . . . Young England, as a biologist, swore by the continuity of the germ-plasm, and laughed to scorn the inheritance of the acquired faculty. (Allen 1890, 538)

Naturalists were divided into warring camps: Poulton, in a letter to a friend, actually made a two-column list of individuals arrayed for and against Weismann's view.[8]

The debates over Weismann's theory are usually remembered simply as debates over the inheritance of acquired characters; the problem is that the latter phrase now evokes an easily dismissed Lamarckism, concealing a number of interesting issues. Looking more closely at the relevant texts reveals that the factors debates concerned the importance of organism-environment interaction during ontogeny and its role in evolution, and thus the origin and nature of variation—problems which remain relevant today (Barker 1993; West-Eberhard 2003; Jablonka and Lamb 2005; Laubichler 2010; Schwander and Leimar 2011).

That the relation between organism and environment framed late-nineteenth-century discussions of the factors of evolution is most clearly seen in the work of the three scientists who in 1896 co-discovered what we now refer to as the "Baldwin Effect": Henry Fairfield Osborn, Conwy Lloyd Morgan, and James Mark Baldwin. The Baldwin Effect occurs when environment-induced (and presumably adaptive) ontogenetic variations give groups of organisms time to develop corresponding

[7] In their later debate, Weismann capitulated to Spencer on this point, formulating his theory of germinal selection—or selection on elements of the heritable material—as a means of "directing variation" at the organismic level (Weismann 1895, 432). For more on Weismann's germinal selection theory, see Winther (2001).

[8] Poulton to Henry Fairfield Osborn, 31 December 1891: Folder 11, Box 77, General Correspondence, Department of Vertebrate Paleontology Archives, American Museum of Natural History.

phylogenetic variations (Kemp 1896; Baldwin 1896). The importance of this purported "new factor," as Baldwin called it, cannot be understood outside of the context of the factors of evolution debates. (In what follows, I will focus on Osborn and Morgan; Christopher Green discusses Baldwin's contributions in the next chapter.)

At a meeting of the American Society of Naturalists in 1891, Osborn lamented that "after studying Evolution for a century we are in a perfect chaos of opinion as to its factors" (Osborn 1891, 193). In Osborn's framing, the debates over these factors were centrally about the power of the environment to produce variations:

> By the [principle of Lamarck] we diminish the powers of Natural Selection, and increase the powers of Environment; at the same time we greatly simplify the problem of Variation, and render far more complex the problem of Inheritance. By the [principle of Weismann] we throw the entire burden of evolution upon Natural Selection, and eliminate the direct action of Environment; we admit definite laws or causes of Variability, but no definite laws governing the variations of single characters; we greatly simplify the problem of Inheritance. In short, the vulnerable point with the Lamarckians is in solving the problem of Heredity, while their opponents are weakest in solving the problem of variation. (Ibid., 197)

Thus, the followers of Lamarck could take the environment as the primary source of variation, but had difficulty explaining how such variation was inherited, whereas the neo-Darwinians had difficulty accounting for the origin of variation, but no problem explaining how existing variation was passed on.

Employing a distinction between ontogenetic and phylogenetic variation, Osborn was also able to argue that variation in a type of organism following a move to a new environment is not necessarily evidence for the direct action of that environment. The following "crucial experiment" is necessary:

> An organism A, with an environment or habit A, is transferred to environment or habit B, and after one or more generations exhibits variations B; this organism is then retransferred to environment or habit A, and if it still exhibits, even for a single generation, or transitorily, any of the variations B, the experiment is a demonstration of the inheritance of ontogenic variations. (Osborn 1895, 97)

The variations in environment B might be induced by that environment during each successive generation; i.e., the B variations could be merely ontogenetic. But if the B variations persist across generations even when the population has been returned to environment A, then they have become phylogenetic. Osborn is here articulating the important point that a variation induced by a reliable environmental cue each generation mimics a congenital variation.

This point about plasticity and reliable cues was made independently by Morgan during a discussion of several experiments by Poulton: "His experiments neither justify a denial nor involve an assertion of the transmissibility of environmental influence . . . . Can we be sure that there is really a summation of results—that each generation is not affected *de novo* in a similar manner?" He continued: "If each plastic embryo is moulded in turn by similar influence, how can we conclusivly [sic] prove hereditary summation?" (Morgan 1891a, 167). Thus, Morgan agreed with Osborn that ontogenetic plasticity could confound tests of the inheritance of acquired characters: "In experiments to test the question of use-inheritance, the

difficulty is to exclude the effects (1) of selection and (2) of individual plasticity." The problem was that "extreme plasticity" could indicate that "the influence of the normal environment is prepotent over the effects of use-inheritance *if* such occur" (Morgan 1891b, 271–272). Hence both Morgan and Osborn highlighted the plasticity of organisms and the environment's role as a producer of variation, but pointed out that such variation was not necessarily heritable.

As Morgan stressed in an essay on Weismann's theories, "all effective variation is a joint product of the inherent activities of germinal cells and the conditioning effect of their environment" (Morgan 1893, 30). Osborn agreed, claiming that organic form is the product of "constitution + the environment" (Dyar 1896, 141). These ideas laid the groundwork for the Baldwin Effect. Osborn presented his version in March 1896 before the New York Academy of Sciences:

> During the enormously long period of time in which habits induce ontogenic variations it is possible for natural selection to work very slowly and gradually upon predispositions to useful correlated variations, and thus what are primarily *ontogenic variations* become slowly apparent as *phylogenic variations* or congenital characters of the race. (Ibid., 142)

The idea of "correlated variations" is the key: it seems that Osborn used this phrase to refer to heritable traits that either mirror or support those traits that had previously been environmentally induced. The basic point is that plasticity, or ontogenetic variation in the face of environmental changes, could give organisms time to develop these correlated congenital variations. The Baldwin Effect was thus a compromise position between Lamarck and Weismann: it emphasized the role of environment-induced variation in evolution without depending on the inheritance of acquired characters. As Osborn put it in a letter to Poulton, "Morgan, Baldwin and myself have independently arrived at certain conclusions regarding the Lamarckian factor which will interest you."[9] Osborn argued that this quasi-Lamarckian process was likely to be important in evolution, "since there is no doubt that the changes of environment and the habits which it so brings about far outstrip all changes in constitution" (Dyar 1896, 142).

Like Osborn, Morgan understood the Baldwin Effect as bearing directly on "the Lamarckian question," and also framed it in terms of the organism-environment relationship. He outlined the effect in a letter to Poulton dated 12 April 1896, with 'variation' referring to changes "of germinal origin" and 'modification' referring to changes "of environmental origin":

> Let us suppose that a group of organisms belonging to a plastic species is placed under new cond'ns of environment. Those whose innate plasticity is equal to the occasion survive. They are modified. Those whose innate plasticity is not equal to the occasion are eliminated. Such modification takes place generation after generation but *as such* is not inherited. In the meanwhile, however, and concurrently, any congenital variations antagonistic in direction to these modifications will tend to thwart them and to render the organism liable to elimination; while any congenital variations similar in direction to these modifications will

[9]Osborn to Poulton, 12 June 1896: Folder 11, Box 77, General Correspondence, Department of Vertebrate Paleontology Archives, American Museum of Natural History.

> tend to support them and to favour the individuals in which they occur. (Natural Selection itself will foster variability in given advantageous lines . . . when once initiated.) Thus will arise a congenital *pre-disposition* to the modification in question. The longer the process continues, the more marked will be the predisposition and the greater the tendency for the congenital variations to conform in all respects to the persistent plastic modifications; while the plasticity still continuing in operation, the modifications become yet further adaptive. When relatively perfect adaptation is reached (the conditions remaining uniform) natural selection will slowly yet surely bring the congenital variations up to the level of such adaptation. Thus plastic modification leads, and variation follows: the one paves the way for the other.[10]

In other words, when organisms are plastic, they can adapt to new environmental conditions even without heritable changes; in the longer term, if the conditions persist, more permanent heritable changes that mirror or extend the environment-induced alterations may appear and, via the ordinary action of natural selection, replace the temporary changes.

Morgan's distinction between environment-induced *modification* and congenital *variation* did the same conceptual work as Osborn's division of "ontogenic variation" and "phylogenic variation." These distinctions allowed Morgan and Osborn to tease apart changes caused directly by the environment each generation and inherited changes, and thus to carve out a role for the environment as a producer of variation without endorsing a Lamarckian theory of heredity (although Osborn did later endorse a form of Lamarckism). Traditionally, supporters of Darwin against Spencer had argued that the primary role of the environment in evolution was as "regulator or preserver of . . . variation" (James 1988, 137, cf. James 1880); the work of Morgan and Osborn provided a richer account in which adaptation involved organism-environment interaction both within and across generations. The environment as both producer and preserver of variation was a central part of this new evolutionary story.

4 Organism and Environment in Philosophy

Spencer, despite his influence on the factors of evolution debates, was primarily a philosopher. Given his popularity in America, it is not surprising that philosophers such as William James and John Dewey used Spencer's work as a foil for their own ideas. James was amusing but often unkind in his descriptions of Spencer, whom he associated with the idea that the mind was merely a product of its environment (Godfrey-Smith 1996, 66–99). As he joked in a May 1877 letter to the neurologist James Jackson Putnam, "would *I* were part of [Spencer's] environment! I'd see if his

[10]Morgan to Poulton, 12 April 1896: C. Lloyd Morgan letters, Entomological Archives, Hope Entomological Library, Oxford University Museum of Natural History. The quoted points are on a separate sheet enclosed with the letter. Emphasis in original. In the original document, this passage is divided into 11 numbered points (nos. 6–17 of 21 total). I have collapsed them for ease of reading, but have not altered the sentence structure. Cf. Morgan (1896, 316–318).

'intelligence' could establish 'relations' that would 'correspond' to me in any other way than by giving up the ghost before me!"[11] Nevertheless, many philosophers who were critical of Spencer inherited his focus on the organism-environment relationship even as they altered his account of that relationship. In this section, I will argue that the idea of organism-environment interaction formed the basis of John Dewey's pragmatist philosophy.

Dewey was first exposed to Spencer's ideas in college at the University of Vermont, where he borrowed the first volume of Spencer's *Principles of Psychology*—which prominently featured the idea of organism-environment interaction—more often than any other book (Feuer 1958). However, it was not evolutionism but idealism that attracted the young Dewey, and during graduate school he attacked Spencer's evolutionary-empiricist account of knowledge (Dewey 1883).[12] When Dewey began teaching Empirical Psychology at the University of Michigan, he struggled to find a textbook that did not simply adopt Spencer's view that the mind was determined by the environment.[13] In 1884, he used James Sully's *Outlines of Psychology*, which followed Spencer in casting mental life as an adjustment of internal to external relations:

> Through innumerable interactions between the nervous system and the environment the former becomes gradually modified in conformity with the latter. Thus nervous connections are built up in the brain-centres corresponding to external relations. The nervous structures are thus in a manner moulded in agreement to the external order, to the form or structure of the environment. (Sully 1884, 58)

Presumably dissatisfied with Sully's approach, Dewey switched in 1885 to John Clark Murray's *Handbook of Psychology*, which he declared "a great advance on Sully in its philosophical basis."[14] Murray attacked the Spencerian view according to which "man's consciousness is simply the product of the forces in his environment acting on his complicated sensibility, and of that sensibility reacting on the environment" (Murray 1885, 415). Thus it appears that Dewey, in his early career, was critical of Spencer's approach to philosophy and psychology.

Despite this critical stance, Dewey twice taught a class on "The Philosophy of Herbert Spencer" in his early years at Michigan, and Spencer's idea of organism-environment interaction soon began to play a role in Dewey's developing philosophy. The influence of Spencer's ideas is apparent in student lecture notes taken in Dewey's "Speculative Psychology" class of 1887. In one of his lectures,

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[11] Spencer to James Jackson Putnam, 26 May 1877, in Skrupselis and Berkeley (1992–2004, 4:564, original emphasis). See also James (1878).

[12] Dewey's mentor in graduate school at Johns Hopkins University, the idealist philosopher George Sylvester Morris, was strongly opposed to Spencer's philosophy. He saw it as British empiricism—which for Morris was vulnerable to a variety of standard idealist criticisms—dressed up with new scientific terminology (Morris 1880, 337–388).

[13] For the classes taught by Dewey at the University of Michigan, see the relevant years of the *Calendar of the University of Michigan*. The class textbook is often listed in the calendar.

[14] Dewey to Torrey, 16 February 1886, in Hickman (1999–).

Dewey argued that mind must be an organic unity. Building up to this point, he said that a stone "has no self at all + hence no unity," as it is "wholly dependent upon outside conditions. None of its parts have any necessary relation with one another nor with the world." Moving up the scale, we call a tree an organism because each of its parts "at same time manifests life of whole + at same time contributes to this life." Nevertheless, even a tree is not truly an organism, according to Dewey:

> Material organism not a complete Individual organism for … [it is] not completely related to all things in the world. Is related to certain things in its environment, those from which it draws its nourishment. But its environment is very limited. It has no direct relation to most things in existence. Higher we go in range of life wider is environment … . If we are to have anything which is completely organic we must have something related to all things however remote or complex. See Spencer's Psyc. Vol I.

The idea that progress in the organic world involves an increase in the number, range, and complexity of organism-environment adjustments is straight out of Spencer's *Principles of Psychology*, as Dewey's citation indicates. But Dewey gave the notion a human-centered twist, arguing that only in our consciousness do we "find a complete organism + hence a true unity or Individual. While there are a great many things in world Indifferent to a material organism there is nothing which is not either actually or potentially in relation to Intelligence. Environment of mind is coextensive with Universe."[15]

The basic problem of knowledge, according to Dewey's idealist account of it in these Speculative Psychology lectures, is the tension between this potentially universal character of consciousness and its inability to realize this potential in practice. We continually overcome this tension by a process of adjustment—of stimulus and response. Environment provides the stimulus: "Man's intelligence dependent for its content upon its surroundings. A mind shut off from contact with the world remains a blank." Prompted by its sensations, "mind must respond to the stimulus and construct something out of this material." Dewey here returned to Spencer's idea of organism-environment interaction, placing it in the context of his idealist account of knowledge:

> Response of mind brings out + makes real for human intelligence relations which are already real for Universal intelligence. This Response includes
>
> 1 – A wider + wider environment
> 2 – A higher development of reacting self.
>
> i.e. range of anyone's world narrowly depends on extent to which it can react to stimuli. World of lowest Organism is simply few inches of surrounding temperature + food. Higher animals will include to certain extent environment of sights + sounds + also certain number of remembered images. Since man has power of reacting in an indefinite number of ways, no limit can be put to his environment. i.e. merely being surrounded by a world does not

[15]Dewey, Speculative Psychology, Lecture 6 (16 March 1887), Box 2, Edwin C. Goddard Papers, Bentley Historical Library, University of Michigan. Cf. Spencer (1880, 1:294). I have replaced abbreviations such as 'Iv.' and 'Uv.' with the terms for which they stand. A copy of these notes is held at the Center for Dewey Studies, Southern Illinois University—Carbondale.

> constitute having a world. To have a world must be also power of selecting + responding to things in the surroundings. See Spencer's Princ. of Psyc. Vol. 1 pp 291–305.[16]

Thus although Dewey employed Spencer's idea of organism-environment interaction, he differed from Spencer in two key respects: first, in the idealist notion of a universal intelligence or consciousness implied by the universal *potential* of our own more limited consciousness; and second, in the emphasis on the mind's active "power of selecting + responding" to the environment. Thus Dewey, inspired by but critical of Spencer, was already developing his own account of organism-environment interaction in the late 1880s.

As I have demonstrated elsewhere, when Dewey began teaching courses on ethics, politics, and Hegel's philosophy in the 1890s, he also started connecting the organism-environment relationship to a dialectical account of adjustment or adaptation (Pearce forthcoming). This account was derived in part from the work of the philosopher Samuel Alexander, who was at the time attempting to combine German philosophy and evolutionary ethics (see Dewey 1894, 885). Alexander worried that Spencer and his followers often seemed to assume "that the environment is itself something fixed and permanent, according to which, as he gradually discovers its character, [the individual] must arrange his conduct." Instead, argued Alexander, "adaptation can only be understood as a joint action of the individual and his environment, in which both sides are adjusted to each other. What the environment is depends upon the character or the qualities of the individual, for it is only in so far as it responds to him that it can affect him at all" (Alexander 1889, 271). Dewey, in his book *Outlines of a Critical Theory of Ethics*, adopted Alexander's notion of adjustment/adaptation:

> Even a plant must do something more than adjust itself *to* a fixed environment; it must assert itself *against* its surroundings, subordinating them and transforming them into material and nutriment; and, on the surface of things, it is evident that *transformation* of existing circumstances is moral duty rather than mere reproduction of them. The environment must be plastic to the ends of the agent. (Dewey 1891, 115, original emphasis)[17]

There are two routes to adaptation, a change in the organism or a change in the environment, and the latter may be more important to understanding human behavior and ethics. Thus Dewey differed from Spencer in emphasizing the importance of construction and reconstruction—i.e., modifications of the environment by the organism—in the (co)-adaptation of organism and environment (see Godfrey-Smith 1996, 131–165).

Dewey's conception of organism-environment interaction, which solidified in the 1890s, became the cornerstone of his philosophy. William James, reviewing the

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[16]Dewey, Speculative Psychology, Lectures 10/11 (13/15 April 1887). Dewey is here citing Spencer's chapters "Life and Mind as Correspondence," "The Correspondence as Direct but Heterogeneous," and the opening of "The Correspondence as Extending in Space" (Spencer 1880, 1:291–305).

[17]In the preface to this book, Dewey lists Alexander's *Moral Order and Progress* among those books to which he is "especially indebted" (1891, vii).

approach of Dewey's "Chicago School" of philosophy and psychology, noted the importance of the conception:

> Like Spencer, . . . Dewey makes biology and psychology continuous. 'Life,' or 'experience,' is the fundamental conception; and whether you take it physically or mentally, it involves an adjustment between terms. Dewey's favorite word is 'situation.' A situation implies at least two factors, each of which is both an independent variable and a function of the other variable. Call them *E* (environment) and *O* (organism) for simplicity's sake. They interact and develop each other without end; for each action of *E* upon *O* changes *O*, whose reaction in turn upon *E* changes *E*, so that *E*'s new action upon *O* gets different, eliciting a new reaction, and so on indefinitely. The situation gets perpetually 'reconstructed,' to use another of Professor Dewey's favorite words, and this reconstruction is the process of which all reality consists. (James 1904, 2)[18]

This basic idea, that experience and inquiry fundamentally involve a mutual adjustment of organism and environment—or transformation/reconstruction of a situation—in response to a concrete problem, would reappear in various guises and contexts for the rest of Dewey's career.

Dewey's famous works on education, metaphysics, aesthetics, and scientific inquiry all depend on the notion of organism-environment interaction. A complete overview is not possible in this short chapter, but the following series of examples gives a sense of how important the organism-environment relationship is in Dewey's philosophical work. In the early pages of *Democracy and Education*—after outlining the meaning of 'environment' and the importance of the social environment—he declares, "we never educate directly, but indirectly by means of the environment" (Dewey 1916, 22). In the Body-Mind chapter of *Experience and Nature* he writes, contra Spencer, "what the organism actually does [in adjusting/adapting] is to act so as to change its relationship to the environment" (Dewey 1925, 283). In *Art as Experience*, describing the reconstructive work of experience as the site of the aesthetic, he says, "attainment of a period of equilibrium is at the same time the initiation of a new relation to the environment, one that brings with it potency of new adjustments to be made through struggle" (Dewey 1934, 17). Finally, in *Logic: The Theory of Inquiry*, he grounds the central idea of an unsettled or problematic situation (which prompts inquiry) in the notion of a "state of imbalance in organic-environmental interactions" (Dewey 1938, 106). The conception of organism-environment interaction that he developed in the 1890s, related to but also critical of Spencer's version, was foundational for Dewey's mature philosophical work. In the pragmatist philosophy of Dewey and James, organism-environment interaction became fully interactive.

[18]This passage describing Dewey's biological approach to philosophy foreshadows the "dialectical biology" of Richard Lewontin, who famously argued that $dO/dt = f(O,E)$ and $dE/dt = f(O,E)$. See Levins and Lewontin (1985, 104–105) and Godfrey-Smith (2001). For more on the Dewey-Lewontin connection, see Pearce (forthcoming).

5 Conclusion

The organism-environment dyad, so prominent in turn-of-the-century scientific and philosophical debates, was also invoked throughout the twentieth century. Both Spencer and Dewey were influential on continuing discussions of the proper role of government and ongoing arguments about the best way to educate children. Both were also important figures in the developing social sciences—anthropology, sociology, and psychology. Dewey's essay on "The Reflex Arc," for example, is often seen as a founding document of functionalist psychology; it even mentions the Spencer-Weismann controversy in a footnote, illustrating the kinship between biological and philosophical discussions at the time (Dewey 1896, 360n2). By the mid-twentieth century, ecology—originally defined as the science of organism-environment relations—had become a key notion for social scientists who wanted to focus on human-environment or culture-environment interactions. Echoes of the 1890s debates described in this chapter can be heard in those of the 1950s, '60s, and '70s (Heft, this volume; Schultz, this volume).

Today, organism-environment talk is more common than ever before. Variation and plasticity are once again major topics in the biological sciences (West-Eberhard 2003; Carroll 2005), and philosophers are increasingly attending to the fact that organisms modify their biological and social environments (Pearce 2011; Barker and Odling-Smee, this volume; Sterelny, this volume). Late-nineteenth-century thinkers such as Dewey and Morgan sometimes seem as if they could have been writing yesterday. Thus looking back at the history of the notion of organism-environment interaction, we also look forward—to a century in which we continue to build with old tools made new.

Acknowledgments I am grateful to Gillian Barker and Eric Desjardins for comments on this chapter. I also received helpful feedback on earlier versions from audiences at the University of North Carolina at Charlotte and at the "Romanticism & Evolution" conference at Western University. Research for the chapter was made possible by generous funding from the Rotman Institute of Philosophy, the Social Sciences and Humanities Research Council of Canada, and the Andrew W. Mellon Foundation. Finally, thanks to the Center for Dewey Studies at SIU-Carbondale, the Bentley Historical Library at the University of Michigan, the Oxford University Museum of Natural History, and the American Museum of Natural History for providing access to archival materials and permission to reproduce some of those materials here.

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