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## Baldwin and Biosemiotics: What Intelligence Is For

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## 1 Introduction

That the species of this world are products of evolution is a fact we no longer have to defend, and thus we no longer need to agree on some unitary, simple mechanism to justify its belonging inside well-established scientific knowledge. Rather we should try to grasp the evolutionary process on Earth as a multifaceted play of creative life processes. That such a process has ultimately created intelligence is a striking fact, which is not easily explained in the absence of a theory of natural intentionality (“aboutness”). Biosemiotics, by positing interpretation in the center of its focus, necessarily admits semiosis as an inescapable feature of life and claims that semiosis (i.e., sign action,<sup>1</sup> see below) was the root-form of intentionality and intelligence. Biosemiotics shares with Baldwinism an ambition to widen up evolutionary theory by putting explicit emphasis on the influence of mental processes in the broadest sense possible of this term, in other words, as comprising semiotic interactions even at the cellular level.

## 2 The Child as Model Organism

Baldwin’s own theory is perhaps best understood and explained from the vantage point of the child. As a child psychologist, James Mark Baldwin was acutely aware of the phenomenon he termed “social heredity”: “that in the child’s personal development, his ontogenesis, his life history, he works out a faithful reproduction of his social conditions. He is, from childhood up, excessively receptive to social suggestions; his entire learning is a process of conforming to social patterns. The essential to this, in his heredity,

is very great plasticity, cerebral balance and equilibrium, a readiness to overflow into the new channels which his social environment dictates" (Baldwin 1902: 53).

Baldwin was also a persuaded Darwinian and in essence what he suggested was that social heredity was operational not only in children but in the animal world at large, although to a lesser extent. In this way he could synthesize child psychology and his belief in Darwinism. He saw the intellectual plasticity of the child, or—in general—the young, as a trait for natural selection to work on, and since "social transmission" is enough to explain the likeness of the father and his son, there is no need for a theory of acquired mental characteristics. Quite to the contrary: "The only apparent hindrance to the child's learning everything that his life in society requires would be just the thing that the advocates of Lamarckism argue for—the inheritance of acquired characters. For such inheritance would tend so to bind up the child's nervous substance in fixed forms that he would have less or possibly no plastic substance left to learn anything with" (Baldwin 1902: 55).

It is instructive to see how Baldwin's Lamarckian opponent, the paleontologist E. D. Cope, responds to the idea of social heredity. First he puts forward the obvious objection that intelligence and social heredity as a factor in psychic evolution is mainly restricted to the higher animals and to man. Then he goes on to assert his belief in the inheritance of mental characteristics, offering the following example as support: "One does not believe in either education or imitation as a cause of the repetition of insanity in family lines. We rather believe in a defective brain mechanism, which is inheritable, though fortunately not always inherited" (Cope 1896: 430).

Thus, in the nature-nurture controversy, strict Lamarckians were no less nature hard-liners than are the Darwinian "fundamentalists" of our days. In fact, one way to conceive of Baldwinism is to see it as a reconciliatory strategy in the nature-nurture controversy: Through his idea of *organic selection*, Baldwin thought that he had shown "that the ordinary antithesis between 'nature and nurture', endowment and education, is largely artificial, since the two are in the main concurrent in direction" (Baldwin 1902: 106). Baldwin illustrated this by reference to complex instincts where physical heredity and social transmission are mixed up. Thus, in certain instincts "we find only partial coordinations given ready-made by heredity, and the creature actually depending upon some conscious resource (imitation, in-

struction, etc.) to bring the Instinct into actual operation." In animals, he says "social heredity serves physical heredity, while in man we find the reverse" (Baldwin 1902: 107).

The controversial point here is Baldwin's belief in "organic selection" as the mechanism by which this concurrence of nature and nurture is effectuated. The essence of organic selection is that "physico-genetic," "neuro-genetic," and "psycho-genetic" adaptations in the life of each single individual allows the individual to survive even under odd conditions, and this survival prevents "the incidence of natural selection," in other words, the destruction of the otherwise unfit. "Thus kept alive, the species has all the time necessary to perfect the variations required by a complete instinct" (Baldwin 1902: 97). Or, in other words, the plasticity of the child's brain, as proved by the fact of social heredity, implied to Baldwin that the necessary genetic settings behind the child's success must have been tuned to facilitate a mentally guided ontogenetic dynamics. Thus, social heredity blurs the outcome of any single genetic variation and institutes a holistic "mental" bond on fitness. And Baldwin speculated that what counts in the child will also count in other animals, although to a lesser extent.

The idea that nature and nurture are not opponents in the ontogenetic process but rather "concurrent in direction" is, in fact, strikingly modern. For illustration let us consider a recent study of the interaction of innate and learned behavior in the cuckoo *Clamator glandarius* (Soler and Soler 1999). Cuckoos are well-known brood parasites—they lay their eggs in the nests of other bird species that incubate the parasitic eggs and rear the young. This may—on Darwinian assumptions—be seen as an elegant way of freeing oneself from the burden of child rearing. The cuckoos have a problem though, for how does a cuckoo young that has been imprinted upon foster parents from a quite different host species become sexually imprinted on conspecifics? Following Lorenz it has generally been assumed that brood parasites were exceptional among bird species in that conspecific recognition was innate, and the main reason for this assumption has been that young brood parasites are assumed never to encounter adult conspecifics but nevertheless to become sexually imprinted on conspecifics (Lorenz 1935).

This last assumption is exactly what Soler and Soler's study seems to reject. When single fledglings of the great spotted cuckoo were artificially

introduced into magpie *Pica pica* nests in areas of allopatry with cuckoos, they did not form groups, whereas they did so if two fledglings were introduced into the same nest. This was taken to show that fledgling cuckoos did not recognize conspecifics when they were reared without any other cuckoo nestling. When the experiment was conducted in the areas of sympatry of magpie and cuckoo, the single fledglings could later on also aggregate normally. It was found that this coincided with the appearance of completely unrelated adult cuckoos who made contact with the fledglings.

It was concluded that sexual imprinting in this species is not an instantaneous and irreversible process. Taken together with observational evidence, the experiments supported the view that adult cuckoos are visiting parasitized nests in the late phase of the nestling period and making contact with fledgling cuckoos. In so doing they imprint young cuckoos (or re-imprint if the chicks had already been imprinted on foster parents), implying that the onset of the sensitive phase for imprinting is delayed in this species, and is still open when contact is made as late as two weeks after fledglings leave the nest (Soler and Soler 1999).

Generalizing these results, we may speculate that avian brood parasites have developed a genetically changed dependence of imprinting on a rather sophisticated scheme of inter-generational semiotic exchanges, and this would seem to perfectly exemplify Baldwin's claim that "nature and nurture" . . . are in the main concurrent in direction" (Baldwin 1902: 106). Nature in this case certainly may be said to have taken advantage of the semiotic means at disposal to the birds.

Another pertinent example of how genetic and cognitive factors have evolved to interact in ontogeny is kin discrimination for inbreeding avoidance in higher animals. As we saw in the cuckoo case, birds often give care to foreign offspring that is placed in the nest, which seems to imply that they do not possess the capacity for direct discrimination between kin and non-kin. Based on reported evidence from a range of different animals, including humans, Swedish anthropologist Bo Gräslund recently concluded that genetical kin discrimination is of limited importance, whereas imprinting through early close contact seems to be the main mechanism for inbreeding avoidance (Gräslund 1998).

This runs somewhat counter to the theory of kin selection that presupposes that animals, in a statistical sense, behave as though they can identify

their genetic kin, determine the degree of this kinship, and estimate whether help to relatives is genetically profitable or not. Several studies have shown that among monogamous species of birds, 25–30 percent of offspring may be the result of extra-pair copulation (references given in Gräslund 1998). Extra-pair offspring are common also among many other monogamous and polygamous animals, including humans and west-African chimpanzees: "This means that a substantial number of males unwittingly feed and care for other males' offspring as if they were their own," writes Gräslund, and he concludes that "reproductive altruism does not operate through allelic identification but through discrimination based on imprinting by early close contact" (Gräslund 1998: 83).

The question of inbreeding avoidance in the human species has had an interesting history. In 1891, the Finnish sociologist Edward Westermarck published ethnographic and sociological data, supporting the idea that taboos against sexual contact within human families, which are found in all societies, are based on an innate inhibition that is activated when small children grow up close to each other and adults live close to small children, in the way that children and mothers, sisters and brothers, and, in general, children and fathers normally do (Westermarck 1891). This idea was fiercely opposed by Sigmund Freud who maintained that incest in humans is basically a reflection of an atavistic instinct inherited from a precultural stage of human evolution, the "primal horde," when reproduction was wholly promiscuously incestuous. Later Freudians found it necessary to dispense with this idea of the "primal horde" as a prehistorical event, but they retained the notions of unconscious desire, guilt, and repression to account for an incest taboo (Stone 1997). Mainstream social science has tended to follow Freud and to reject Westermarck's idea as an undue biologism.

However, as we saw, inbreeding avoidance (the so-called Knight-Darwin law) is widespread in the animal world and Freud's hypothesis of a repressed instinctual basis for incest would place the human animal in a unique reproductive position. Gräslund presents overwhelming empirical evidence for the thesis that early close contact is associated with inbreeding avoidance in human populations. Furthermore, when incest, infanticide, and violence against small children does in fact occur, such acts are statistically committed mainly by men who have not lived close to the child in

question during its early years. "That they are more often stepfathers than genetic fathers is usually seen as an expression of kin selection," writes Gräslund, but, "At the proximal level, it can be explained by the fact that stepfathers generally have experienced the least amount of early close contact with children in question" (Gräslund 1998: 79–80).

According to Westermarck, incest is avoided in human populations because early close contact with children activates an innate inhibition mechanism. One might perhaps speculate that the avoidance was caused by a more general emotional logic pertaining to human sexual schemata, but this does nothing to detract from the general Baldwinian conclusion that the productive interplay of the hereditary component and the cognitive component is indeed a central theme of human ontogeny. And it can hardly be denied that this interplay is also important in the ontogeny of mammals and birds.

For Baldwin nurture is not just feeding and protecting, but a grand social process of individuation:

The society into which the child is born is, therefore, not to be conceived merely as a loose aggregate, made up of a number of biological individuals. It is rather a body of mental products, an established network of psychical relationships. By this the new person is molded and shaped to his maturity. He enters into this network as a new cell in the social tissue, joining in its movement, revealing its nature, and contributing to its growth. It is literally a tissue, psychological in character, in the development of which the new individual is differentiated. He does not *enter it* as an individual; on the contrary, he is only an individual when he comes out of it. . . . In the personal self, the social is individualized. (Baldwin 1913, quoted in Doise 1996)

We think it is fair to say that biologists have tended to underestimate the intricacies of the nurture project, thus failing to see the true challenge it poses to the understanding of genetics, in other words, to see, as Baldwin did, the true complexity of ontogeny as subtly determined by a non-additive interplay between genes and social minds.

### 3 Intelligence and Semiosis

The term intelligence was used by Baldwin and his contemporaries in a very broad sense. In fact, Baldwin juxtaposes intelligence to instinct to the effect that either an activity is instinctual or it is intelligent. Here again he is explicitly opposing the Neo-Lamarckian idea that instincts are cases of so-

called lapsed intelligence. Toward this view Baldwin holds that "intelligent adaptation does not create coordinations; it only makes functional use of coordinations which were alternatively present already in the creature's equipment . . . in instinct the muscular coordination is brought into play *directly* by a sense stimulation; while in intelligence it is brought into play *indirectly*, i.e., through association of brain processes, with selection of fortunate combinations" (Baldwin 1902: 63–64).

Needless to say, the extent to which different animals possess intelligence has been highly disputed. It has often been overlooked, however, that intelligence is not just something you have "between the ears," but is very much a social skill, an ability to use physical marks as well as social relations to scaffold and organize your knowledge.

From the very beginning nerves were developed as tools for movement. Their task was to facilitate "long-distance communication" between cells in different parts of a moving animal. But the presence of fast-moving animals implied the creation of fast-moving environments, and brains developed to allow certain animals to cope with this situation in new ways. The combinatorial possibilities of moving in a moving world are enormous, of course, and from the beginning the task of brains was to help the animal to make proximal decisions that might be assisted by learning but that could not possibly be based on genetic anticipation. Brains were means for nurturing nature.

One aspect of brain action that may deserve special emphasis is proprioception, that is, the awareness of movement and position. Even the simplest movements presuppose a continuous feedback from proprioceptive organs in the body measuring muscle tensions and displacements of cell layers including the sense of gravitational orientation. The American philosopher Maxine Sheets-Johnstone has recently suggested that the proprioceptive sense serves as a "corporeal consciousness": "Any creature that *moves itself*, i.e., that is not sessile, senses itself moving;<sup>2</sup> by the same token, it senses when it is still. Distinguishing movement from stillness, motion from rest, is indeed a fundamental natural discrimination of living creatures that is vital to survival" (Sheets-Johnstone 1998: 284). It was the French philosopher Maurice Merleau-Ponty who first, in 1945, observed that "originally consciousness is not a 'I think that' but a 'I can'" (Merleau-Ponty 1945: 160). Sheets-Johnstone echoes this insight when she writes that "A creature's

initiation of movement is coincident with its kinesthetic motivation, its dispositions to do this or that—turn, pause, crouch, freeze, run, or constrict; its kinesthetic motivations fall within the range of its species-specific movement possibilities . . . [which] are the basis of its particular repertoire of ‘I cans,’” and further: “any item within its repertoire of ‘I cans’ is undergirded proprioceptively (kinesthetically) by a sense of agency” (Sheets-Johnstone 1998: 285).

It is a well-known fact that animals can and do dream. This implies that the mental states may sometimes be uncoupled from bodily action. But the extent of uncoupling between behavior and mental activity that characterizes the human mind is probably unique to that specific animal. The uncoupling has made philosophers wonder how it can be that mental states are always “about” something. But seen in the perspective of biology, this is no wonder, since mental “aboutness,” human intentionality, grew out of a bodily “aboutness” (Hoffmeyer 1996). Whatever an organism senses also means something to it: food, escape, sexual reproduction, and so forth. This is one of the major insights brought to light through the work of Jakob von Uexküll: “Every action, therefore, that consists of perception and operation imprints its meaning on the meaningless object and thereby makes it into a subject-related meaning-carrier in the respective *Umwelt*” (Uexküll [1940] 1982). “*Umwelt*” was Uexküll’s term for the phenomenal worlds of animals, the subjective universe in which the animals live, or, in other words, the ecological niche as the organism itself perceives it.

Seeing the “I can” as the center around which mental processes are evolutionarily organized has the effect of blurring the traditional mind-body dichotomy. Body action and mind action are not entirely separate categories but are essentially connected through the intentionality of the animal in which they occur, and mental activity is just one peculiarly sophisticated extension of traditional animal behavior. It follows from this understanding that we do not necessarily have to operate with two quite different categories such as “phenotypic flexibility” versus “learning.” Again, learning is just one particularly sophisticated kind of phenotypic flexibility.

The embodiment of mental processes has been a recurrent theme in cognitive science and neural biology during the latest decade and paradoxically even in robotics (Lakoff 1987; Varela et al. 1991; Damasio 1994; Deacon 1997; Lakoff and Johnson 1999; Hendriks-Jansen 1996; Clark

1997). But the coin has two sides, and while the naturalization of human intelligence has attracted much attention, the other side of the coin, the inherent intelligence of nature, has not drawn such attention.

Biosemiotics can be seen as an attempt to operationalize this neglected part of the insight in the embodied nature of the mental sphere (Hoffmeyer 1992; 1995; 1996). That mental life is embodied has the implication that its natural history cannot be separated from embodied life. Mental life is grounded in bodily intentionality as manifested in perception-action cycles, and thus ultimately in semiosis. Semiosis, in the understanding of the American philosopher and scientist Charles S. Peirce, is a triadic process whereby a *sign* provokes the formation of an *interpretant* to stand in a relation to an object that somehow reflects the relation in which the sign itself stands to this same object.<sup>3</sup> For illustration, smoke can be seen as a sign that normally provokes the formation of an interpretant (neural processes) in the mind of a human observer, which relates to fire in a way echoing the way smoke itself relates to fire. Likewise a certain concentration of adrenaline may become a sign to the extent it provokes the formation of an interpretant in a liver cell (a cascade of enzymatic processes ultimately releasing free glucose molecules), which relates to an actual stress situation in the same way that the hormone production itself relates to the stress situation.

People from science and humanities alike often object to such an idea by pointing to the interpretative freedom of the human observer compared to the law-bound nature of the adrenaline-caused cellular response. Thus the human observer may know that the smoke he is observing is probably faked since he is just watching a piece of drama, but the liver cell, so the argument goes, does not have any possibilities for not responding to the adrenaline. But is not this argument hiding a strange lapse of logic? Or do we really believe that some mysterious soul-factor enters the man’s brain cells and induces an element of freedom not else seen in cellular life?

We prefer thinking that already the liver cell is underdetermined to the extent that the contextual situation in which it finds itself does—if ever so weakly—enter the myriad relational connections making up for cellular control. For instance a diversity of cellular recognition processes are mediated by the same G-proteins, and different G proteins can occasionally be utilized by the same receptor. This enables the cell to vary its response to a given signal. As Maurine Linder and Alfred Gilman have put it: “The



ability of receptors, G proteins, and effectors to interact with more than one species of molecule inside the cell also means that a cell can make different *choices* from time to time—now sending a signal down one pathway and now directing it along a somewhat different route” (italics added; Linder and Gilman 1992).

Biosemiotics searches the precursor processes out of which mental life arose and claims that cellular and organismic, semiotic processes predate the appearance of genuine intelligence and mental life, and that semiosis should be seen as a germ form of intelligence. The social nature of intelligence immediately become apparent in this approach, since semiosis transcends traditional (efficient) causality by its triadic nature, that is, by its inclusion of the contextual situation in which the causal processes unfold.

In an attempt to transcend the tradition of idealistic philosophy, American philosopher John Dewey observed that

The true stuff of experience is recognized to be adaptive courses of action, habits, active functions, connections of doing and undergoing; sensori-motor coordinations. Experience carries principles of connection and organization within itself. . . . These principles are none the worse because they are vital and practical rather than epistemological. Some degree of organization is indispensable to even the lowest grade of life. Even an amoebae must have some continuity in time in its activity and some adaptation to its environment in space. Its life and experience cannot possibly consist in momentary, atomic, and self-enclosed sensations. Its activity has reference to its surroundings and to what goes before and what comes after. This organization intrinsic to life renders unnecessary a super-natural and super-empirical synthesis. It affords the basis and material for a positive evolution of intelligence as an organizing factor within experience. (Dewey 1948: 91)

Thus, by allowing a semiotization of nature, the subject-object separation that has marred European philosophy may be softened. Organisms, and the cells and tissues of which they are built, are not just objects but also subjects in the sense that they are semiotic agents capable of interacting with their surroundings in “clever” ways. The history of how these semiotic interaction patterns have been scaffolded into the myriads of ontogenetically consistent dynamics of this world, that is, the life cycles of organisms, is what evolution is about. Genetic fixation of course plays a crucial role in such scaffolding but we believe that there are countless semiotic ways of obtaining a relatively secure scaffolding of intra- and interspecific interaction patterns (called semethic interactions by Hoffmeyer 1995). We see no reason to believe that all—or even most—of these semiotic scaffolding mech-

anisms are unambiguously coded for in the genomic set-up. On the contrary, we think there are serious reasons to believe they are not, since flexibility is the core of such semiotic scaffolding (Bateson 1963).

#### 4 Nonselective Adaptation: Semiosis as a Factor of Evolution

All organisms have at least some capacity for making distinctions and for making choices. Whether this ability to distinguish and to choose may be a factor in evolution has been a subject for long debates in the theory of evolution. Darwinian evolutionism has generally rejected it, for instance, when stating that all adaptive evolution is a result of natural selection exclusively; according to this view, an ability to use sign processes may turn out to be an advantage in the struggle for existence (like many other features, e.g., an ability to move quickly), but it cannot be itself a factor that is sufficient for creating evolutionary adaptations.

However, since one of the fundamental biosemiotic views states that semiosis is a creative process also in an evolutionary sense, it will be highly interesting to analyze the possible evolutionary mechanisms that include sign processes from the very beginning. On this basis, a model has been suggested to account for adaptive evolution in the absence of natural selection (Kull 2000). Basically this model depends on the fact that nonfunctional parts of the genome undergo a much more rapid change than do functional parts of the genome. It is further assumed that whenever a population finds itself in a state of changed conditions, the “reading” of the genome will change, so that certain genomic sections will now be less expressed, or not at all, whereas others will become functional. Given these assumptions, it follows that if the changed state is maintained for many generations, the formerly functional but now nonfunctional parts of the genome risk being damaged. Eventually this may block the way for a return to the original state. The implication of this is that an irreversible adaptive specialization has taken place in the absence of any differential reproduction of genotypes. This mechanism can be called “evolution via forgetting of unused,” and it was concluded “that adaptive evolution is a more general process than the adaptive evolution via natural selection” (Kull 2000: 48).

Theoretically, this kind of nonselective evolution “allows a much higher speed of adaptive evolutionary specialization than when evolution is restricted

by the mechanism of differential reproduction" (Kull 2000: 50). Thus, the appearance of a new adaptation may occur simultaneously for the whole population during just one generation as a response to the self-organizational and communicative capacities of organisms. The eventual genetic fixation of the change will of course take many generations, but the mechanism will nevertheless allow for a fast evolutionary change compared to the traditional case where the new adaptation first appears as a mutation in single organism, which then gradually via the competitive advantage become distributed over the population.

The occurrence of nonselective adaptations may also indicate a solution to the debate on punctualism and gradualism. The data that led to the formulation of punctualism came from morphological studies of phylogeny, showing alternating periods of stasis and change. Evidence from molecular data, on the contrary, shows that lineages change gradually. This is exactly what the mechanism as described above predicts—the morphological change and the genetic change may not necessarily be concurrent. That is, morphological change may begin as an ontogenetic adaptation that is quickly developed compared to the subsequent genetic fixation, which may typically depend on a large number of generations.

The main statements from which the conclusions given here follow is that (a) organisms have many different ways to behave and build oneself from the exact same genome; and (b) organisms may behave in the same particular (constant) way for quite a large variety of genomes. In other words, (a) an organism has many ways to interpret its genome; and (b) there are other inheritance mechanisms than the genetic one (e.g., epigenetic, or just the stability of the environment), which enables organisms to keep some features of their structure and behavior unchanged even if some changes in the genome take place.

In other words, the organism's phenotype and genotype are not so strictly coupled as is often assumed because in general an organism does not make use of its whole genome for living, and there exist potentially more functionally expressible parts in the genome than those that are currently in use. And also, there are many different ways to live using the same genome, as is for instance dramatically illustrated by the dreaded locust, which most of the time lives its life as an ordinary, harmless grasshopper, but which under certain conditions, generates new generations with a markedly changed

morphology and behavior, causing these locusts to form enormous flocks flying many thousand kilometers, and devouring every green thing in their path (Hoffmeyer 1996: 20).

Essentially this phenotypic flexibility depends on semiotic activity (which includes perception and operation, i.e., the functional cycle, according to Uexküll 1928), and particularly, on the mobility of populations causing changes in both selection and environment, that is, niche construction (Laland, Odling-Smee et al. 1996; Odling-Smee, Laland et al. 1996). Thus, the uncoupling is a result of the cooperation between two levels of functional circles possessed by cells (or phenomes)—one of these acting via the genome, the other via the environment.

A cell may not only interpret its genotype in different ways, it also has several ways to preserve a particular interpretation over a number of generations through epigenetic inheritance mechanisms, or due to a permanent change of environmental conditions. This may eventually supply the time needed for stochastic genetic changes to accumulate in unused segments of the genotype and thus to fix the otherwise only phenotypic changes. For instance, this means that if for many generations a particular organic structure has not been formed, it may not be possible for this particular organic structure to be formed at a later time, due to stochastic changes in the part of the genome which normally scaffolded this particular step in cellular differentiation.

It is important to notice that a similar interpretational shift may take place simultaneously in many individuals of a population (e.g., as a result of invasion of the population into a new environment, for instance in the case of monophage or oligophage insects when they inhabit a new host species). The phenetic shift that this implies may be sufficient to decrease the efficiency of recognition of the source population specimens (which is needed for mating) down to the level that guarantees the sufficient isolation and provides time to the mutation processes to fix this separation also at the level of genome or cytoplasm incompatibility (Kull 1988; 1993; Paterson 1993).

Here, we would like to draw attention to an interesting paradox of natural selection, which was called the *paradox of the unique child* (Kull 2000). That is, in the case of sexual reproduction, almost every descendant has a genotype that has never been present before (e.g., in the sense of a new

combination of alleles of the whole genome) and whose capacity for survival and reproduction has therefore never been checked by natural selection. Nevertheless, a considerable percentage of the offspring—particularly in the species that have a low reproduction rate—will usually stay alive.

The explanation for this apparent paradox is that every organism has many ways to carry out the tasks they need to fulfill. Structures or processes that happen to be corrupted can most often be substituted by others or repaired in some way or other. For instance small quantitative changes in efficiency of one particular enzyme can often be compensated by small changes in the production of other enzymes, without this having any real influence upon reproduction. Also, for the most part, it is not necessary for a living organism to be a hundred percent precise at the digital level (DNA).

For a new character to appear in the phylogeny of species, it is not necessary to assume that there had to be one specimen who gained this character first due to mutation, and that then this mutation became spread over the species to all those whose grandparent that first mutant individual is. This would be required only if digital preciseness in the determination of the character is assumed. As far as this is not the case, many different genetic changes in many individuals of the population may simultaneously give rise to the same new character. And the final genetic fixations of the new character (in the sense of making its appearance irreversible) may have taken place only a long time after the first appearance of this character in the paleontological record.

The Baldwin effect implies that evolution may take place without differential reproduction of genotypes. Assuming that mutations in the expressed part of the genome cause inviability of a near equal percentage of the offspring from all individuals of the population involved in an interpretational shift, we have a mechanism of evolution that works without the differential reproduction of genotypes. The neo-Darwinian mechanism is thus a special case of this mechanism, since it requires an additional assumption (e.g., that the percentage of inviable offspring is systematically different in different individuals, and this difference is correlated with a particular genetic character of parents).

The stochastic (entropic) changes in genotype preferentially lead to the forgetting of “unused” and the storing of “used.” Owing to the large size

of genomes in terms of the number of genes, many mutations are always simultaneously distributed among individuals via sexual reproduction, thereby enabling the ontogenetic change to become fixed for the whole population (making the phenotypic change irreversible); theoretically, this is a much faster mechanism than the classical one, which requires a distribution of new mutations to take place across the population through competitive advantage.

The proposed “Baldwin effect” mechanism is supported by recent studies on epigenetic inheritance mechanisms, and on the stability of morphogenetic mechanisms (Jablonka and Lamb 1995; Webster and Goodwin 1996).

We conclude that an organism is itself a subject in the continued evolution of the lineage to which it belongs. This is exactly what was originally implied by the so-called Baldwin effect. As an obvious implication of this understanding, we need to direct our attention toward the evolutionary function of interpretations and semiosis.

## 5 Phenotypic Plasticity for Semiotic Competence

The term organism immediately implies the term environment—the one cannot exist without the other—and therefore to ask for the origin of life is also to ask for the origin of the environment (Hoffmeyer 1998). Or to state this differently, life is process in context, and one major theme in organic evolution has been the interiorization of the context into the organism, that is, in the course of evolution, organisms have learned to make more and more sophisticated internal representations of selective aspects of their external situations. This representational activity is the root of biosemiosis and since it is deeply integrated into the survival strategies of the organisms, it is an intentional activity, that is, a precursor for that dimension of the life process we find exhibited in higher animals as intelligence, semiotic control, and eventually consciousness.

Even bacteria continuously measure the presence of bacterial waste products or nutrients in their surroundings, compare such measurements through time, and interpret these compared measurements through the execution of historically acquired activity patterns such as attraction or repulsion. To the extent these historically acquired activity patterns have



become fixed as solutions to survival challenges of ancestral organisms, they can be conceived of as virtual realities, just like the virtual realities produced by patterns of firing neurons in our brains. Our virtual realities have an experiential quality to them that is probably absent in bacteria and other brainless animals or plants, but one cannot be sure that this aspect of our mental processes have no precursors in bacteria.

When Conrad Waddington introduced his image of *canalization*, that is, of development as a ball running down through the valleys of an epigenetic landscape whose features are largely determined as a concerted effect of a multitude of genes, he tried to establish an autonomous role for embryology in evolutionary theory. Genes according to this idea do not directly cause traits; they rather assist in laying out the features of the epigenetic landscape, and, therefore, in the pattern of canalizations open to embryonic development. By emphasizing the autonomous role of this dynamic intermediate level, the epigenetic landscape, between genotype and phenotype, he attempted to transcend the behavioristic black-box conception of the organism.

Not only genes but also environmental factors might influence the features of the epigenetic landscape making phenotypic plasticity possible. Waddington thought that natural selection would tend toward some kind of balance between genetic fixation and phenotypic plasticity, and this was the key to his idea of "genetic assimilation" (Waddington 1957: 168). A crucial factor for the evolution of phenotypic plasticity is now thought to be the relation between the time scale of environmental change and the generation time. Phenotypic plasticity is believed to be beneficial only if this ratio is low, that is, if the environment may be expected to change a lot in the lifetime of every single individual (Gordon 1992).

All of these discussions take on a new dimension when considered in the light of semiotically controlled behavior or, in general, activity. Behavior is what the organism needs the Umwelt for; that is, their trajectories into the real world are guided by their *virtual realities*. If the Umwelt does not guide the activity of the organism successfully, the organism's chance of leaving offspring is hampered, and it follows that the assurance of the production of well-tuned umwelt is one important focus for the evolutionary process.

An implication of this is that there is not only one layer pushed in between the genotype and the phenotype, as Waddington suggested, but that

in addition to the epigenetic landscape guiding the pattern of developmental canalizations, there must also be an epi-developmental, semiotic *umwelt landscape* canalizing the learning processes whereby a particular umwelt is calibrated to the actual environmental circumstances (Hoffmeyer 2001).

The reality of the organism's virtual reality is assured by a calibration process in the combined or integrated epigenetic and Umwelt landscapes whereby the rigidities of genetic predisposition are transcended. For that same reason the Umwelt cannot be strictly bound by its genetic basis but must to some extent reflect the unpredictability of endless semiotic recombinations between adaptive developmental elements and environmental elements (what Bateson 1979 called a double stochastic system).

Another way to state this is by the observation that phenotypic plasticity at the level of semiotic competence may be orders of magnitude bigger and not well-correlated with phenotypic plasticity at the morphological level. For instance, morphological plasticity is predominant in most unicellulars as well as in plants and fungi, but much less so in insects, mammals, or birds. Ultimately, this is because the semiotic niche (i.e., that subset of the local semiosphere which the species must be capable of controlling [Hoffmeyer 1996]) is both a more subtle and a much richer concept than the ecological niche since it encompasses all latently relevant cues that have to be correctly interpreted by the organism if its success shall be assured. Since the number of features of the world, which may in some situation or other become relevant cues governing the behavior of an organism, is infinite, or at least orders of magnitudes bigger than the number of features with which the organism has to interact physically, the semiotic aspect opens the door to a very versatile adaptive landscape. Thus a bird, to take an example, not only has to deal with a range of items for food or shelter, but also with patterns of sounds, directions, and speeds of wind, differences in temperature of air or wind, changing intensities and wavelengths of light, and so on—or even, as is the case with some migratory birds, with the shifting constellations of stars. And clearly at this level, many kinds of environmental changes are to be expected in the lifetime of an individual organism.

We conclude that the inclusion of life's semiotic dimension into the evolutionary theory complex considerably strengthens the case for Baldwinian thinking. It becomes obvious that organisms do not passively succumb to

the severity of environmental judgment. Instead, they perceive, interpret, and act in the environment in ways that creatively and unpredictably change the whole setting for selection and evolution.

## Notes

1. "If we ask what it is that semiotic studies investigate, the answer is, in a word, action. The action of signs" (Deely 1990: 22).
2. Unicellular organisms who can move themselves (e.g., using flagellum), may not always be able to distinguish between the moving of the body and the changes or movements in their surrounding. In that respect, Sheets-Johnstone's statement is slightly overstrained. However, the principal meaning of her statement is clearly correct.
3. According to Peirce, "A sign, or Representamen, is a First which stands in such a genuine triadic relation to a Second, called its Object, as to be capable of determining a Third, called its Interpretant, to assume the same triadic relation to its Object in which it stands itself to the same Object" (Peirce 1931–1935: vol. 2, no. 274). Thus, in Peirce's philosophy the interpretant represents a category of "thirdness" that transcends mere causality, which he saw as "secondness."

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## 14

## The Hierarchic Logic of Emergence: Untangling the Interdependence of Evolution and Self-Organization

Terrence W. Deacon

### 1 Introduction

[... something more from nothing but.¹]

Biological evolution is characterized by a collection of highly convoluted processes that produce a remarkably complex kind of combinatorial novelty. The contention of this paper is that biological evolution and evolutionary processes in general are a subset of processes drawn from a much larger set of novelty-producing processes that also includes self-assembly and self-organizing processes. Not only does it appear that these are related concepts, I think it is also clear that they are interdependent in complex and subtle ways that have yet to be fully delineated, especially in the processes of life and mind. It is also suspected by many writers that a synthesis that successfully integrates the logic of these various kinds of creative processes will do more than significantly advance our understanding of how life came about and how thoughts and experiences are generated. It could possibly also provide new insights into the very nature of physical causality. But there are some broad theoretical issues that stand in the way of this outcome. These issues derive from a set of unresolved problems about the nature of physical novelty itself, and how we conceive of its origination in terms of current theories of causality. These most enigmatic physical phenomena all have something to do with creative or origination processes in nature, and for this reason seem inevitably to come in conflict with our otherwise quite successful, reductionistic account of most other aspects of the world.