

Further considerations on semiosis in evolution: Arbitrariness plus semiotic fitting, and/or mutability plus natural selection

Kalevi Kull¹

Abstract. This essay attempts to combine some recent theoretical results in (bio)semiotics on arbitrariness, semiotic fitting, umwelt, choice, and extended theory of evolution into a more coherent whole. The proposed model describes a living being through its subjectivity and the ability to create meaning, which are often overlooked in models based on replicability. The concept of the umwelt is divided into two – the synchronic umwelt and the distributed or diachronic umwelt. For the latter, a new term ‘umweb’ is introduced. A mechanism of evolution is described in which arbitrary relating followed by semiotic fitting is somewhat analogous to the neo-Darwinian mechanism of random mutations followed by natural selection. The paper proceeds to discuss the alternativity and coexistence of these two radically different ways of evolution and learning.

Keywords: agency; free choice; biosemiotics; existential semiotics; extended synthesis; general semiotics; learning; lower threshold; semiosis; theory of evolution; umweb; umwelt

... diachronic evolutionary processes do not necessarily go from simple to complex in matter, any more than they do in mathematics.

Robert Rosen, *Essays on Life Itself* (1999: 114)

Much of biology has been done as if semiosis did not exist, for instance in the case of population genetics. Since population genetics is the field that has provided the theoretical basis for the formalized concept of natural selection, and through this for a theory of evolution and adaptation, such a theory of evolution has also been marked by the absence of meaning-making and provided an incomplete understanding of the dynamics of life.

¹ Department of Semiotics, University of Tartu, Jakobi 2, 51005 Tartu, Estonia; e-mail: kalevi.kull@ut.ee.

The conceptual apparatus of general semiotics as based on biosemiotics is being updated step by step. Among other things, this allows specifying what the semiotic aspect can add to the understanding of evolution. A number of works have been devoted to the semiotic approach to biological evolution (Yčas 1969; Pattee 1969; Florkin 1974; Bentele 1984; Barbieri 1985; Kull 1992, 1998, 2016; Bouissac 1993; Witzany 1993; Rothschild 1994; Nöth 1994; Sebeok 1997; Deacon 1997, 2021; Cariani 1998; Hoffmeyer, Kull 2003; Hoffmeyer 2010a; 2012; Kleisner 2010; 2022; Maran, Kleisner 2010; Andrade 2011; Müller 2012; Favareau 2015; Hateren 2015; Hoffmeyer, Stjernfelt 2016; Markoš 2016; Sharov 2016; Sharov, Maran, Tønnessen 2016; Maran, Tønnessen 2016; Maran 2017; Anastasi 2017; Winters 2018; Chebanov 2019; Rodríguez H. 2023; etc.; see a review in Sharov, Kull 2022; also Kull 1999: 54–58), but there is much more to be done.

The semiotic theory of evolution should be an important complement to and refinement of the extended theory of evolution (Pigliucci, Müller 2010; Kull 2022a). Using the works listed above, this paper briefly describes a model of semiotic evolution which in many ways is alternative (while somewhat analogous) to the model of evolution based on natural selection.

Generally, adaptive evolution can be described as innovation plus fitting. In case of evolving replicators (as in population genetics), innovation comes from the impreciseness of replication (mutations), and fitting is due to differential replication. In case of evolving agents, innovation comes from the arbitrariness of relating, and fitting is due to the practising of sign relations.

I *Prolegomena*

Agency and semiosis

If a small pebble is carried into a crack in the rock by waves and fits right into it, this has no *meaning*, except perhaps to some external observer. The situation is no different if there is a living organism (for instance, a seed) instead of the pebble, inasmuch as it was carried into the crack by a wave, controlling of whose movement was not in the organism's power. However, the situation is different if a living organism *chose* this location.

An active living organism, as opposed to an inactive or a dead one, can be described as a complex of processes that have some freedom of behaviour. The nature of such freedom has been a major enigma for biology, and not only for biology. Free behaviour in the sense of spontaneous activity has often been described as agency (e.g. in Walsh 2015; Sharov, Tønnessen 2021; Di Paolo, Buhrmann, Barandian 2022). The precise criterial characteristics of agency still

remain unclear; however, a review of the concept of agency in biosemiotics points out its relatedness to choice and freedom (Tønnessen 2015: 139–140).

Earlier, I have characterized agency as a system with logical incompatibility (Kull 2015a: 618). This may look paradoxical since this statement says that agency is illogical. Indeed, logical incompatibility can appear only *between* rules or codes, where non-contradiction is not yet set. It does not seem to happen in a finite, correctly working mechanism, as in the completely algorithmic models in science, which are necessarily built on the condition of non-contradiction. This means that codes or algorithms are not enough for agency – what is required is the incompatibility of codes. Agencies so defined should be called *semiotic agencies*.

Thus, the problem of “how to get from matter to mind” becomes reformulated as “how to get from the non-contradictory world to contradiction”. This would be the problem of the origin of semiosis. As I have argued elsewhere (Kull 2015a), this is equivalent to the origin of specious present, the finite moment of the Now, the subjective time – because two rules can only be incompatible if they are both *present*, i.e. simultaneous. Since this is not an easy-to-solve trivial problem, some would claim that “matter” is “contradictory” “all the way down”, assuming that this is a feature of a quantum world. Such a swerve is tantamount to running away from the interesting fundamental problem. Besides, “all the way (down)” is what one cannot know. But the origin of semiosis is not the focus of the present essay.

Logical incompatibility itself implies indeterminacy – the situation in which there is no algorithm to determine the action; therefore, it implies free choice. According to such understanding, an agency is a process of *having to make choices*. Choices can be arbitrary, so the agent does not necessarily require any purpose or goal when making a choice. This is a situation in which there is an absence of rules – it is freedom (of choice); in certain limits, of course. The rules (or habits) will be set as a result of the repeated choices.

Such a view can be described as eco-existentialism, or bio-existentialism. Martin Heidegger describes the agential condition as “thrownness into the world”, or a state of “thrown-ness” (*Geworfenheit*) in the present (e.g. Heidegger 1996[1927]: 128), thrown for choice-making. On the basis of this, Eero Tarasti has developed an approach that he calls ‘existential semiotics’ (Tarasti 2015; 2023). According to such biosemiotic existentialism, the “world” provides possibilities, and the organism is in conditions in which it has to make choices. This “world”, however, is not the environment – it is the organism’s *umwelt*. The nature of the *umwelt* lies in it being options-provider, and in its simultaneity – it is the space of multiplicity, the multiple at the same present moment, not yet temporally organized. Such features exist only because of the organism, or semiotic agent. According to this model, agency and *umwelt* are coextensive with semiosis.

A significant shortcoming of the theory of evolution has been the exclusion of several general characteristics of living organisms as factors or conditions for evolution. Neo-Darwinian theory has not needed any general characteristics of life other than reproduction, mutability and inheritance. Indeed, reproduction, mutability and inheritance are enough for the mechanism of natural selection. It is sufficient, however, only if the agent's behaviour does not leave traces that affect subsequent generations. Moreover, even agents are not required for the theory of natural selection. Still, there are agents. And when behaviour can have long-term consequences, which it can, the general features of agency come into play.

Semiosis and, accordingly, agential life, has several general features, among them the following:

(a) Energetic and structural metabolism. That is, the agent does physical work; this provides a general condition for downward causation.

(b) Homeostatic subsystems. These are mechanisms that ensure the stability of the agent as a dynamic system. The homeostatic metabolic system also requires an autocatalytic network, as do thermodynamic dissipative systems.

(c) Relationality and codes. While the conditions (a) and (b) are not restricted to semiotic systems, relationality is. Relationality is based on habits, rules or codes; these are what distinguishes a relation from other types of interactions. As emphasised by Jacques Monod (1971: 143), "the code's structure is chemically arbitrary". Martynas Yčas, a scholar who worked in the main group that discovered the genetic code, has written: "The most difficult part of the code problem has been to arrive at the concept that a code exists. This required at least a century of work" (Yčas 1969: 13). One important and rather productive discussion in the biosemiotics of recent decades has concerned the relationship between code and meaning-making, the difference between code and interpretation (see references in Kull 2020a), and their relationship to agency (also in the context of the difference between algorithms or codes in machines without semantics, and habits as codes *sensu lato* with internal semantics). According to Ferdinand de Saussure, the most general feature of sign relations is their arbitrariness. Arbitrariness differs from randomness by its requirement for work and difference-making; it is always in some extent constrained (or motivated, in terms of Saussure). Codes *sensu stricto* (while arbitrary and participating in semiosis as its building blocks) are insufficient for meaning-making because of their determinism.

(d) Providing options, i.e. multiple possibilities. The inclusion of more than one relation is a condition for being able to interpret. Interpretation is the basic process of meaning-making; as based on definitions of these concepts, there cannot be a sign without interpretation – there can be no semiosis without interpretation.

(e) Simultaneity of action and its perception. What makes a sign relation different from other relationships, is its non-sequentiality, i.e. the simultaneity of its relata. This implies the necessary existence of the extended moment of time – the subjective present – in all meaning-making processes. The complexity of processes that take place at such a single moment of time corresponds to the complexity of the sign as interpreted.

(f) Memory. If semiosis that creates a relation leaves some traces that modify the semiosis that follows (i.e. if the semiotic system has memory), then it can also learn. Memory as a trace is extrasemiotic, the trace as a physical pattern is not a relation, while working as the scaffolding or constraint for semiosis (Hoffmeyer 2007; Kull 2015b). Thus, semiosis both presupposes and produces something extrasemiotic. As formulated by Lauri Linask (2022: 197), “Memory is something that grounds the identity of semiosis [...]. In a cognitive present, memory relates a past choice with future interpretations. From that point of view, memory is not for preserving the past, but for anticipating the future”. Capacity of learning has been demonstrated for single cells.

(g) Habits. Systems with the capacity of interpretation and learning can form habits. Habituation is the process in which the constraints for interpretation become narrower, and therefore the whole semiotic process becomes more and more automatic, which means that in terms of the complexity of semiosis the sign relation becomes simplified. This is also a process in which new codes are formed. Habit is different from a code *sensu stricto* by its interpretative feature; habit is at the same time semiosis, while a code alone is not.

The listed features are not independent, as already seen from their description. Any semiotic activity presupposes an agent – which includes a metabolic system that can provide physical energy for the process of interpretation (and accordingly, for choice) to be carried out. The semioticity of an organism is based on its (sub)logical incompatibility. This is where subjective experiencing starts.

One should distinguish between semiotic and non-semiotic processes. Semiotic processes presuppose semiosis, while non-semiotic processes do not. In case of several terms used for description of information processes (learning, coding, translation, communication, signalling, memory, behaviour, evolution, etc.) such a distinction has often not been made, at least not made clearly. Accordingly, adaptive changes can be of a semiotic or a non-semiotic kind. Semiotic learning and evolution presuppose semiosis, while non-semiotic learning and evolution do not. Distinguishing between them is an aim of the current work.

The concept of semiosis was introduced into semiotics by Charles Peirce, and nowadays it is understood as a sign process which includes interpretation and formation of interpretant. Semiosis is thus the process that, according to its triadic

model, relates the representamen, the object, and the interpretant. There exist also other models of semiosis, for instance the pentadic one by Charles Morris, which adds the context and the interpreter to the previous three relata. From the current point of view, context and interpreter can be seen as a part of *umwelt*, and agent, respectively. Biosemiotic models of semiosis may be even more complex, specifying the necessary conditions for semiosis in more detail.

Homeostasis, homeorhesis, and habit

If one begins the modelling of life processes with replication, this will consistently lead to neo-Darwinian theory. The addition of the niche construction was seen as an opportunity to extend or even invert the neo-Darwinian theory. However, J. Scott Turner has argued that, in its common deterministic interpretation, this is not enough, as niche construction for its evolutionary impact still requires natural selection and thus can be seen as a part of neo-Darwinian theory. Turner believes that homeostasis must be taken as a basis: “Agency in living systems is distinctive because it is an expression of a fundamental property of life, homeostasis” (Turner 2016: 209). As he shows, adaptation can work in the absence of natural selection. When basing theory of life on homeostasis (a term introduced by Cannon 1929, 1932), Turner also asserts that homeostasis should not be understood in simple cybernetic terms as a computational mechanism (Turner 2019).

A term that generalizes the concept of homeostasis is ‘homeorhesis’. Introduced by Conrad H. Waddington, this term describes a property of a dynamical system to preserve a particular trajectory; homeorhesis is “stabilized flow rather than stabilized state” (Waddington 1968: 12). Commenting the work of Waddington, René Thom (1968: 33–34) proposed a formalization of this concept, concluding: “I feel that the homeorhesis concept still has much to offer to mathematicians” (Thom 1992: 6).

Raymond and Denis Noble make a further transformation of the definition when writing: “[in case of homeostasis] the controlled variables hunt around their mean values while [in case of homeorhesis] the organism seeks to optimize its functions on many processes at the same time” (Noble, Noble 2023: [3]). The existence of several concurrent homeostatic mechanisms makes the trajectory of the organism hardly predictable, or even indeterminate, if the directions of these homeostatic mechanisms occur as incompatible in the moment of the present.

What may both add uncertainty, as well as diminish it in the organism’s dynamic process, is a kind of learning which is habit-formation: namely, semiotic learning (i.e. one in which a choice is made between several simultaneous possibilities)

that forms new relations. If stabilized by relators (to use the term by Günther 1979: 224), the relations may turn into deterministic codes. A new habit as a new rule, on the one hand, may decrease uncertainty for situations that are common, while, on the other hand, it may increase uncertainty since new situations for incompatibilities between the rules may appear.

Homeostasis is a physiological concept; habit is a semiotic one. However, they are related. Both homeostasis and habit stabilize the system's dynamic. Homeostasis stabilizes the dynamics in the changing conditions; habit stabilizes dynamics in the conditions of free choice. There are not many works in semiotics in which the concept of homeostasis has been explicitly used; in this context, Juri Lotman (1977: 196) at least touches the problem:

One of the chief sources of the dynamism of semiotic structures is the constant process of drawing extrasystematic elements into the realm of the system and of expelling systematic elements into the area of non-system. A refusal to describe the extrasystematic, placing it beyond the confines of science, cuts off the reserve of dynamism and presents us with a system in which any play between evolution and homeostasis is, in principle, excluded. The stone that the builders of a formed and stabilized system reject for being, from their point of view, superfluous and unnecessary, turns out to be the cornerstone of the subsequent system.

Nevertheless, there is one more characteristic of semiotic agents that would require explanation.

Umwelt and umweb

Organisms as semiotic agents have their *umwelten*. The *umwelt*, a concept introduced by Jakob von Uexküll (see e.g. Uexküll 1928), has been commonly defined as the subjective world of the organism. A somewhat similar insight led Kenneth Boulding to argue that “behavior depends on the image” (Boulding 1961: 6). In a general sense, once an organism can make distinctions, once it uses signs and can choose, it should also have an *umwelt*. The *umwelt* is the world with meanings. On a closer inspection, however, there are at least two different concepts behind this term, when the relationship with time is taken into account: the momentary *umwelt* (the *umwelt* proper) and the distributed *umwelt* (for which the paper proposes the term ‘*umweb*’).

The momentary *umwelt* is an *umwelt* in its proper sense – the meaningful world of an organism. Meaning is the relation that exists now, a difference in the present, atemporally (synchronically) in the subjective time. This is a simultaneous existence of distinguishables, which are the possibilities or the options for behaving.

Distinction itself is a relation. Since such is the core sense of Uexküll's concept – subjective space in identical time,² – the term 'umwelt' will be reserved for this concept.

The distributed umwelt is the web of meaning-relations over the course of time (diachronically), both intra- and inter-organismically. For this, the term 'umweb' is proposed.³ Umweb is the whole set of sign relations that organisms have throughout their life. Umweb is the complex or nexus of habits. Habits are relations, and their relata can belong to one and the same organism, or to behaviourally linked organisms. Since such relations can include other organisms in one's umweb, and sometimes reciprocally between organisms (if the organisms together create a habit of their interaction), it means that these organisms are semiotically linked. Through such relations, umwelten of different organisms are encompassed by the umweb. The umweb can be called the knowledge of the organism. If the umwelt is personal, the umweb makes it possible to cover the interpersonal. The umwelt is closed, the umweb is open.

There exist some notions that are close to that of the umweb. Uexküll himself uses the term 'umwelt tunnel', meaning by this the temporal sequence of an organism's subjective moments during its ontogeny or life cycle (Uexküll 1928: 70). The umweb may be described as the complex of semiotic relations in which the organism is involved, while the umwelt tunnel is a sequence of momentary umwelten.

A close concept to 'umweb' is 'senome', as introduced by František Baluška and William Miller; they define it as "the sum of all the sensory experiences of the cognitive cell and its sensing apparatus" (Baluška, Miller 2018: 1). They propose that "the Senome [the sum of 'senes'] is the collective attachment to the informational matrix of the environment that propels internal cycles of biological information upon which all cells depend" (Baluška, Miller 2018: 3).

² Cf. Rogers (2022: 460–461): "The formative principle of space is *identity in difference*, or *Sameness*. Space equalizes difference by uniting given particulars through general forms. Space is *exteriority*", while "the formative principle of time is *difference in identity* or *Otherness*. Time is the duration of particular identity within systems of differentiation. Time is *interiority*."

³ The word 'umweb' was initially coined as a name for a small publishing house by Dario Martinelli, together with Merja Bauters and Guido Ipsen, at a semiotics seminar in 2003 in Helsinki (*pers. comm.* from Dario Martinelli). The editorial group of Umweb included also Kaie Kotov, Natalya Sukhova, and Kalevi Kull. Umweb published a series of books on semiotics, e.g. Bauters, Ipsen, Martinelli 2004, Witzani 2006, 2007, etc. However, as a term marking a semiotic concept 'umweb' has not been used until now. Dario Martinelli wrote to me that he appreciates this use (20 February, 2023).

Another concept somewhat close to ‘umweb’ is ‘semiosphere’, a term introduced by Juri Lotman and later, independently, also by Jesper Hoffmeyer. The semiosphere includes meaning-relations of all agents, thus serving as an umbrella term. Among comparable concepts we can also find ‘*Lebenswelt*’ as a solely human umwelt, ‘actor-network’ as a material-semiotic network of agents, and ‘chronotope’ as the spacetime of a narrative.

The next section addresses the main two concepts necessary for a semiotic theory of evolution.

II *Evolutio*

Arbitrariness

The concept that characterizes (or even defines) freedom is arbitrariness, that is, the quality of relations in which the relata can be ordered in ways other than chance and other than mere physical necessity. The ability for such arbitrary ordering underlies the possibility of choice in living systems. The premise of this ability is the uncertainty inherent in simultaneous representation of available possibilities. In semiotics, arbitrariness is a feature that characterizes the relationship between the signifier and the signified – this was the main understanding of Saussure, which directed him in his studies of the structure of human language. Indeed, his “Principle I: The arbitrary nature of the sign” states: “The bond between the signifier and the signified is arbitrary” (Saussure 1959[1916]: 67). Arbitrariness, being to some extent restrained by motivation, is the basis that organizes the structure of sign systems.⁴

It is important to emphasize that arbitrariness does not mean randomness. Arbitrariness means ‘any one among the available possibilities’. An arbitrary choice is a free decision made by an agent. It is not stochastic.

All sign relations are both arbitrary and constrained. Options may not be equal to exercise. One may take more effort or more time than another (while this does not imply that it is always the one that takes the least effort that is chosen). Therefore, it is not correct to divide signs into arbitrary and motivated ones. Instead, constraints of arbitrariness vary.

In order for an arbitrary relationship to be repeated in the same form, an independent mediator is necessary. Independence of the mediator (relator) means that the mediator is restored independently from the relata it is going to relate. A

⁴ According to one definition, semiotics is the study of all the forms and all the (possible) consequences of arbitrariness (Chávez Barreto *et al.* 2022: 448). This concurs with Chebanov’s (2017: 65) formulation of “life as a chronic miracle of a violation of regularities”.

well-studied example of such a mediator is the set of tRNAs which are responsible for the genetic code. Building of new relators is the basis of associative learning.

Arbitrariness exists due to work. Living systems are all doing work. This allows them to be independent from microfluctuations or stochasticity, and therefore to be able to make choices.

An arbitrary choice, or free choice, does not presuppose any goal or purpose. It may include more motivation or less motivation in some direction, but so long as the motivation is not a necessity, and so long as there still is the capacity to behave against the motivation, the choice is free – it is still a choice (Kull 2023).

When comparing the genetic code with the linguistic code in Saussure's sense, one fundamental difference must be noted. In the case of a linguistic code (correspondence between a sound image and a concept), the correspondence has a freedom, which is completely absent in the genetic code. Namely, linguistic codes involve choice. For example, in the case of the sound image /ia/, a person who knows both Russian and Estonian has the freedom to interpret this sound combination as corresponding to the word 'я' in Russian (= 'I' in English) or the word 'ja' in Estonian (= 'and' in English). Even the slightest freedom of choice means that we are dealing with interpretation, that is, with semiosis, that is, we can talk about meanings. In the case of the genetic code, there is no possibility for choice, since there is no interpretation, which means that the relationship between a codon and an aminoacid established by tRNA does not itself make meaning. It is important to add that differences in the codon-to-amino-acid correspondence in different variants of the genetic code do not constitute freedom of choice, because the alternatives are not presented simultaneously.

This implies that codes are always semiotic, in the sense that the correspondence carried by code differs from physical correspondences and is transmitted through an independent mediator that has the role of memory (for example, tRNA, or neural connections). However, the existence of a code does not necessarily mean the existence of semiosis, since for semiosis it is still necessary that there be a matter of interpretations, but interpretation by definition presupposes the possibility of interpreting one way or another, otherwise it is not an interpretation. In conclusion – the genetic code is arbitrary, and in that sense the code is semiotic, while it does not constitute meaning, because it has no (or has lost its) freedom, therefore it is not semiosis.

Arbitrariness is a feature of relations, the type of independence between the relata that makes innovativeness possible. Next, other important characteristics of relations are observed.

Semiotic fitting

A sign relation, if repeated, is called a habit. Habits have two separate general features, and it is reasonable to distinguish them terminologically. First, there is the repetition itself, which leads to habituation. Second is its functionality, the aspect of tuning and adjusting, which is fitting. Thus, the Peircean broader term ‘habit’ can be divided into two – habit in a narrow sense as a repetitive sign relation, and semiotic fitting as the habitual function of the sign relation (Kull 2020b).

The concept of semiotic fitting was introduced as a specification of the ecological fitting described by Daniel Janzen (1985). Janzen used an example of the fruit piles close to a tree around which small frugivorous organisms would gather and stay. The *recognition* process required for finding the fruits is, by definition, semiotic; therefore, in order to distinguish such gatherings from stochastic movements, the term ‘*semiotic fitting*’ can be used for their relation (Kull 2020b). Differently from the neo-Darwinian concept of fitness that describes reproductive success, semiotic fitting describes functionality of sign relations and aboutness.

Semiotic fitting (or fit, or compatibility) is the kind of fitting that has been formed through semiosis and is maintained through sign relations, habits, and ultimately by codes. It differs from physical matching in that it is mediated and chosen. Moreover, this is a mediation process that creates a functional (semiotic) fit. A number of remarkable properties are associated with semiotic fitting:

(a) Discontinuity. Common physical features (e.g. mass, velocity, viscosity) are continuous, while semiotic features (e.g. meaning, reference, difference) are discontinuous – these re-emerge anew in each act of semiosis. Accordingly, physical links can be permanent by themselves (as based on cohesion, molecular forces, chemical affinity, etc.), while semiotic links have to be permanently re-established (as based on recalling, recognition, remembering, etc.). In order to persist, a semiotic relation has to be repeated. For that, more permanent constraints (called semiotic scaffolding, or memory), are required.

(b) Memory. If an organism makes an arbitrary choice between its possibilities of behaviour, this usually leaves a trace. This is not a change in its genome, but a change in the organism’s place, or in its environment, or in its conditions, or in its metabolism. If it is a change in the organism’s environment, it may influence the conditions for its further choices. If it is a change in its metabolism, this may also influence its further choices. The effects of choices that influence further choices work as memory – they *are* memory, by definition. However, memory does not only leave a trace, thus modifying the scaffold or constraints, but leaves such a trace which allows restoration – that means, makes a modification of a self-reproducing or self-restoring system. The possibilities for such modification

are rather restricted, because restorability (or recoverability) includes several preconditions that must not be violated.

(c) Self-modification. Once there is feedback to an arbitrary choice, i.e. feedback that could change the probability of making that choice, this choice tends to be repeated. Such choice does not require any goal; feedback is enough. Repetition of a certain behaviour usually leaves some traces in the organism itself. In the simplest case, it eases or facilitates the repetition of the behavioural act, which means habituation (including sensitization). Learning by habituation is the simplest, and very widespread, form of learning, so simple that it is often not even considered as a type of learning. A result of this mechanism is that the constraints to arbitrary choices tend to change towards a feedback structure (cf. Markoš *et al.* 2009).

(d) Problem solving. Another aspect of arbitrary choices between possibilities is that they solve the problem posed by the multiplicity of possibilities the organism is facing. Each choice temporarily solves such a problem in the sense of removing the situation of incompatibility. The possibilities themselves are affected by the organism's decisions. Accordingly, the possibilities turn into habits – the ways an organism can manage. This is fitting – and *semiotic* fitting because it is based on recognition and choice-making, which are themselves aspects of semiosis and cannot occur outside of semiosis.

(e) Inheritance. Several of the choices the organism makes have cross-generational effects: habitat choice, food choice, partner choice, niche construction, etc. Some of these choices have an impact on the next-generation gene pool of the population – partner choice makes a direct impact, while several other choices that influence partner choice work indirectly.

It can be noticed that semiotic fitting generalizes the concept of affordance (Campbell, Olteanu, Kull 2019). Indeed, semiotic fitting is a concept that exemplifies and contextualizes the concept of affordance. Since semiotic fitting is based on interpretation process, it can also be described as differential recognition.

Behaviour as based on the *umwelt* has an important feature that makes it possible to learn without the mechanism of trial and error. Trial-and-error learning is sequential (cf. Miller, Galanter, Pribram 1960). *Umwelt* as a moment is non-sequential. This implies that decision-making in an *umwelt* is based, as we can term it, on synchronic logic.

The fundamental reason why free choice implies semiotic fitting lies in the nature of memory. Memory is always partly extrasemiotic (see above). Therefore, arbitrary behaviour not only becomes repeated but also acquires the feature of fitting, or, in other terms, modelling, or knowing. Consider the trajectory of arbitrary movement in a space with boundaries: the trajectory forms a pattern

that tends to reflect the form of that space. Due to memory, the trajectory builds an *umweb*, a model of that space that fits semiotically. Due to the momentary *umwelt*, the model turns into a meaningful whole.

Arbitrariness and semiotic fitting instead of random mutations and natural selection

Now it is time to turn to the diachronic dimension of life and make a comparison between two kinds of processes that work in the evolutionary dynamics of the organic world and can be labelled as ‘physical’ and ‘semiotic’: ‘physical’ in the sense that it does not require any meaning-making processes in its mechanism, and ‘semiotic’ in the sense of being based on interpretative processes, that is, semiosis. The elements of these two modes of evolution can be put into correspondence as shown in Table 1.

Table 1. Comparison of two principal ways of adaptive evolution.

	physical	semiotic
innovation	mutation	arbitrary choice
inheritance, recurrence	replication, reproduction	habituation
adaptation	natural selection (differential reproduction)	semiotic fitting (differential recognition)

There are three general components in any non-neutral evolutionary change. First, there is innovation – a modification that does not entirely follow from the existing structure of the organism, “a new feature that endows its bearer with qualitatively new, often game-changing abilities” (Wagner 2011: 1). The new feature can be a rather little detail, of course. Second, this innovation should persist, either via inheritance or repeatability. And third, it has to find a correspondence or fit with other elements of the organic system (its ecosystem).

The first thing to recognize when comparing the physical and semiotic mode of evolution, is that an arbitrary choice can be as innovative for a living system’s workings as a mutational change in its chromosome. Second, habit is also a mode of inheritance as is replication; both require constraints. And, third, differential copying and differential recognition both shift the system towards congruence. Thus, we can conclude that the physical and the semiotic versions logically do (almost) the same.

Thus, there are two mechanisms of adaptive evolution, one based on natural selection, the other based on semiotic fitting. Besides similarities, they also have radical differences. The physical one depends on the permittance (selection) by conditions, it does not require agency, while the semiotic one depends on the agential choice and recognition of differences. In less robust terms, natural selection propagates and strengthens the aspects of globality, standardness, competitiveness, while semiotic fitting does not propagate and leads towards individuation, uniqueness, contextuality, locality, symbioticity.

Is differential reproduction (i.e. natural selection) required for evolution by arbitrary turn and semiotic fitting? Obviously, it is not, as there is no reason to doubt the possibility of several individuals making a similar turn (i.e. learning the same habit) in similar conditions. This concurs rather well with Lev Berg's description: as conceived by Darwin, evolution was "based on chance variations, to which single and solitary individuals are subject", while as understood on the basis of Berg's non-Darwinian view (which he calls 'nomogenesis'), evolution was "based upon laws, affecting a vast number of individuals throughout an extensive territory" (Berg 1969[1922]: 406). However, 'law' should not be understood here in the sense of a physical law, but rather in the sense of the Peircean habit.

Evolution by semiotic fitting appears to be potentially much faster than evolution by natural selection. Why then is actual evolution so slow? There are probably several reasons for this. First, the possibilities for transgenerational inheritance are much narrower than they are in case of direct genetic change. Second, communicative mechanisms are rather conservative. And third: the umweb is a single whole, it is complete in the sense of semiotic fit to everything that supports the life cycle, and it is rarely possible to find anything in an umweb that might be changed – other than fine tuning towards perfection. However, some evolutionary changes, for instance, exaptations, are relatively rapid. The nature of exaptations is the change in interpretation (Weible 2016).

III *Disputatio*

Life itself is not a mechanism (in the sense of Rosen 1991; cf. Henning, Scarfe 2013; Sharov, Tønnessen 2021). It is not a replication machine, randomly mutating and surviving as allowed by natural selection. Instead, life is a multiple sensory-motor system with diverse possibilities of its behaviour. Such plurality is due to the Umwelt in which choices can be made. Life is plastic, which means it can (at least to some extent) learn, or, to put it in different terms, it has memory. Due to the existence of the Umwelt, organisms have the capacity for free choice, and since

there are several forms of non-genetic inheritance, there is also an independent evolutionary mode provided by semiotic processes.

It should be emphasized that the existence of evolution by semiotic fitting does not mean that evolution by natural selection does not exist. These are two separate and rather independent modes of evolution which can work in parallel, but in different proportions. In case of *Prokaryota*, rather obviously the natural selection prevails, while in some groups of *Eukaryota* (particularly in *Animalia*), evolution by semiotic fitting may prevail. Measuring these proportions is a task for future research.

The model of semiotic fitting as compared to natural selection leads to a series of interesting implications. According to the theory of natural selection, higher fitness as reproductive success usually means greater abundance. In contrary, additional semiotic fitting does not mean that it would imply an increase in abundance. The relationship is rather the opposite – the more perfect the semiotic fitting, the rarer the species may be, because of its higher context-dependence. Besides, rarity is generally not causally linked to persistence (Vermeij, Grosberg 2018). The fact that rarer species become extinct more often is mainly the case in periods when the environment changes considerably, because their rich habitual structure (the diverse *umweb*) cannot use its potentials, the earlier relations cannot reappear due to the absence of some of their *relata*.

In case of evolution by semiotic fitting, the main unit is not population as it is for evolution by natural selection, but lineage (see Sharov, Kull 2022). Via their lineages, the currently living organisms have permanently been alive since the origin of life. Accordingly, all their evolution has been taking place via modifications during their lifetime. Organisms' physiology homeorhetically adjusted as the environment changed, or as the genome changed. Deaths of some organisms or lineages have had almost no role in the evolution of living organisms (except having had an influence by interrupting some relations with species that have become extinct, and by the changes in the environment due to these extinctions).

Umwebs are at least to some extent inheritable through their traces or scaffoldings that their sign relations build, even if the *umwelten* themselves are discontinuous. Therefore, lineages can be seen as the lineages of *umwebs*.

Jablonka and Ginsburg (2022) have proposed that consciousness *sensu lato* is coextensive with associative learning. The model described here includes *umwelt*, which was not explicitly focused on by Jablonka and Ginsburg (Kull, Favareau 2022). However, these models can be seen as compatible, if the establishment of a new relation in an *umwelt* is seen as a minimal form of associative learning. The *umwelt* itself is a kind of association – the association of various relations in simultaneity.

A rather universal feature of living systems is communication – dialogue. From the momentary umwelt perspective, the formation of a new relation is like communication or dialogue in the simultaneity. This phenomenon is of particular interest in minimal conditions, without the participation of the nervous system. Such a life situation – the dynamic state – should be indeterminate, i.e. with the real alternative possibilities existing at the moment of dialogue as an interpretative event. Here are some hypothetical minimal cases which could be studied in this respect.

(a) Dialogue between functional circles having separate receptors, which are linked to the same movement organ (including the functional circles in the motile unicellular organism).

(b) Dialogue-like interactions between the homologous chromosomes in the diploid cell, or in the process of fusion of haploid cells into a diploid cell, where alternative possibilities are provided by the choice between homologous, but still somewhat different chromosomes.

(c) Dialogue between the halves of a bilateral body. Bilateral symmetry is a very common form of organisms, prone to the dialogue between halves. For instance, consider the role of pulvinus at the base of leaves in *Dicotyledoneae*, that allows the petiole to integrate the percepts from the left and the right halves of the leaf and accordingly to move and reorient the whole blade in various directions as dependent on conditions.

Be that as it may with these examples, on many other occasions the life process contains features of dialogue, either autocommunicative or heterocommunicative, intrapersonal or extrapersonal, a dialogue which is not only sequential, but fundamentally simultaneous, in the sense that the partners create the momentary umwelt together. These communicational processes lead to the building and modification of the umweb, the network of habitual and meaningful relations that keep up the living and semiotic core of ecosystems, their semiotic bonds. The umweb with its innovative powers also serves as a system of recovery and harmonization of ecosystems, with its capabilities to restore and work as eco-immunological system.

The prevalent tendency in semiotic development and evolution is towards multiple and more perfect semiotic fitting. This can be identified with the aesthetic process (Kull 2022b). It should be noted that emergence of beauty has also been explained as based on the evolution by natural selection and reproductive success (e.g. Voland, Grammer 2003). However, such selectionist approach uses a rather anthropomorphic concept of beauty and does not take into account the quick experiential processes as an independent source of aesthetic relations. Thus, it is less general than an explanation based on semiotic fitting that accounts for the nature of aesthetics itself. Semiotic fit is admittedly logical, not mechanical.

IV Conclusio

Hoffmeyer (2010b: 193) writes: “The difficult problem⁵ to solve in any theory of the origin of agency and life is how to unify two normally quite separate kinds of dynamics: a dynamics of chemical interaction patterns and a dynamics of signification or semiosis.” Namely this has been the task here: to distinguish between semiotic and non-semiotic dynamics and to demonstrate their co-work in living systems.

According to the population genetic model, evolutionary change is based on random mutation and differential reproduction (natural selection). Analogously, according to the semiotic model, evolution is based on arbitrary choice and differential habituation (semiotic fitting).

The population genetic model is population-based. What is commonly meant by ‘the population’ is a genetically diverse population of organisms; however, the model has also been applied to a population of cells in the tissues of multicellular organisms (e.g. Edelman 1987; Weissman 2015). Instead, the semiotic model is based on agential lineage with diverse habits, while agents can be of various complexity, including a symbiotic community of organisms or cells.

Population genetic change is evolutionary due to genetic inheritance. Semiotic change, in order to become evolutionary, requires additional kinds of inheritance – epigenetic, social, ecological (Jablonka, Lamb 2005).

There are many nuances and varieties of both models (cf. Pigliucci, Müller 2010; Deacon 2016; De Loof 2017; Svensson 2023). The independence of evolution by semiotic fitting from evolution by natural selection has rarely been described clearly enough, which explains why their relationship and proportion have not been sufficiently studied. The concept of the *umweb* may help open up the otherwise rather closed *umwelt* (in its phenomenological interpretation) and link the *umwelt* with social and evolutionary processes. A semiotic approach improves understanding of the dynamics (and aesthetics) of organic life.

Acknowledgements. I thank Ene-Reet Soovik, Ott Puumeister, Denis Noble, Raymond Noble, Elena Gorokhovskaya, Riin Magnus, Donald Favareau and other colleagues for helpful discussions on some aspects of this study, and PRG314 for support.

⁵ In his original manuscript, Hoffmeyer wrote ‘hard problem’ instead of ‘difficult problem.’

References

- Anastasi, Alessandra 2017. Biology, learning, and evolution of vocality: Biosemiotics of birdsong. *Cognitive Semiotics* 10(1): 19–39. <https://doi.org/10.1515/cogsem-2017-0002>
- Andrade, Eugenio 2011. Natural abduction: The bridge between individuals choices and the production of evolutionary innovations. *Signs* 5: 112–146.
- Baluška, František; Miller Jr., William B. 2018. Senomic view of the cell: Senome versus genome. *Communicative & Integrative Biology* 11(3): 1–9. <https://doi.org/10.1080/19420889.2018.1489184>
- Barbieri, Marcello 1985. *The Semantic Theory of Evolution*. (Models of Scientific Thought 2.) Chur: Harwood Academic Publishers.
- Bauters, Merja; Ipsen, Guido; Martinelli, Dario (eds.) 2004. *Semiotics from S to S: A Selection of Not-So-Serious Semiotic Studies*. Helsinki: Umweb.
- Bentele, Günter 1984. *Zeichen und Entwicklung: Vorüberlegungen zu einer genetischen Semiotik*. (Kodikas/Code suppl. 15.) Tübingen: G. Narr.
- Berg, Leo S. 1969[1926; 1922]. *Nomogenesis or Evolution Determined by Law*. (Thompson, D'Arcy Wentworth, intr.; Dobzhansky, Theodosius, intr.; Rostovtsov, J. N., trans.) Cambridge: The MIT Press
- Bouissac, Paul 1993. Semiotisches Wettrüsten: Zur Evolution artübergreifender Kommunikation. *Zeitschrift für Semiotik* 15(1/2): 3–21.
- Boulding, Kenneth 1961. *The Image: Knowledge in Life and Society*. Ann Arbor: The University of Michigan Press.
- Campbell, Cary; Olteanu, Alin; Kull, Kalevi 2019. Learning and knowing as semiosis: Extending the conceptual apparatus of semiotics. *Sign Systems Studies* 47(3/4): 352–381. <https://doi.org/10.12697/SSS.2019.47.3-4.01>
- Cannon, Walter Bradford 1929. Organisation for physiological homeostasis. *Physiological Reviews* 9: 397–431. <https://doi.org/10.1152/physrev.1929.9.3.399>
- Cannon, Walter Bradford 1932. *The Wisdom of the Body*. New York: W. W. Norton.
- Cariani, Peter 1998. Towards an evolutionary semiotics: The emergence of new sign-functions in organisms and devices. In: Vijver, Gertrudis Van de; Salthe, Stanley N.; Delpo, Manuela (eds.), *Evolutionary Systems: Biological and Epistemological Perspectives on Selection and Self-Organization*. Dordrecht: Kluwer Academic Publishers, 359–376.
- Chávez Barreto, Eugenio Israel; Miyamoto Gómez, Oscar S.; Bennett, Tyler James; Lacková, Ludmila; Kull, Kalevi 2022. Funktionskreis and the biosemiotic signifieds: Towards the integration of semiotics. *Sign Systems Studies* 50(2/3): 433–452. <https://doi.org/10.12697/SSS.2022.50.2-3.07>
- Chebanov, Sergei 2017. Meronomy of the living semiotic means. In: Kull, Kalevi; Cobley, Paul (eds.), *Biosemiotics in the Community: Essays in Honour of Donald Favareau*. Tartu: University of Tartu Press, 65–69.
- Chebanov, Sergei 2019. Na puti k semioticheski osoznaemoj biologii: biosemiotika zameshchaet sinteticheskuyu teoriyu evolyutsii. [Towards a semiotically informed biology: Biosemiotics replaces the synthetic theory of evolution.] In: Il'yin, Mihail V. (ed.), *Metodologicheskie aspekty transdistsiplinarnogo transfera znaniy*. (Metod 9.) Moscow: RAN INION, 151–173. [Чебанов, Сергей В. На пути к семиотической осознаваемой биологии: биосемиотика замещает синтетическую теорию эволюции. In: Ильин, Михаил В. (ed.), *Методологические аспекты трансдисци-*

- плинарного трансфера знаний. (Метод 9.) Москва: РАН ИНИОН, 151–173.]
<https://doi.org/10.31249/metod/2019.09.10>
- Deacon, Terrence 1997. *The Symbolic Species: The Coevolution of Language and the Brain*. New York: Norton.
- Deacon, Terrence W. 2016. Reconsidering Darwin's "several powers". *Biosemiotics* 9(1): 121–128. <https://doi.org/10.1007/s12304-016-9263-6>
- Deacon, Terrence W. 2021. How molecules became signs. *Biosemiotics* 14(3): 537–559. <https://doi.org/10.1007/s12304-021-09453-9>
- De Loof, Arnold 2017. The evolution of "Life": A metadarwinian integrative approach. *Communicative & Integrative Biology* 10(3): e1301335 (pp. 1–14). <https://doi.org/10.1080/19420889.2017.1301335>
- Di Paolo, Ezequiel; Buhrmann, Thomas; Barandian, Xabier E. 2017. *Sensorimotor Life: An Enactive Proposal*. Oxford: Oxford University Press.
- Edelman, Gerald 1987. *Neural Darwinism: The Theory of Neuronal Group Selection*. New York: Basic Books.
- Favareau, Donald 2015. Creation of the relevant next: How living systems capture the power of the adjacent possible through sign use. *Progress in Biophysics and Molecular Biology* 119(3): 588–601. <https://doi.org/10.1016/j.pbiomolbio.2015.08.010>
- Florkin, Marcel 1974. Concepts of molecular biosemiotics and of molecular evolution. *Comprehensive Biochemistry* 29A: 1–124.
- Günther, Gotthard 1979. *Beiträge zur Grundlegung einer operationsfähigen Dialektik: Zweiter Band*. Hamburg: Felix Meiner Verlag.
- Hateren, Johannes Hendrik van 2015. The natural emergence of (bio)semiotic phenomena. *Biosemiotics* 8(3): 403–419. <https://doi.org/10.1007/s12304-015-9241-4>
- Heidegger, Martin 1996[1927]. *Being and Time: A Translation of Sein und Zeit*. (Stambaugh, Joan, trans.) Albany: State University of New York Press.
- Henning, Brian G.; Scarfe, Adam C. (eds.) 2013. *Beyond Mechanism: Putting Life Back into Biology*. Lanham: Lexington Books.
- Hoffmeyer, Jesper 2007. Semio-genic scaffolding in nature. *International Journal of Applied Semiotics* 5(1/2): 81–94.
- Hoffmeyer, Jesper 2010a. Relations: The true substrate for evolution. *Semiotica* 178(1/4): 81–103. <https://doi.org/10.1515/semi.2010.006>
- Hoffmeyer, Jesper 2010b. Semiotic freedom: An emerging force. In: Davies, Paul; Gregersen, Niels Henrik (eds.), *Information and the Nature of Reality: From Physics to Metaphysics*. Cambridge: Cambridge University Press, 185–204. <https://doi.org/10.1017/CBO9780511778759.010>
- Hoffmeyer, Jesper 2012. The natural history of intentionality: A biosemiotic approach. In: Schilhab, Theresa; Stjernfelt, Frederik; Deacon, Terrence (eds.), *The Symbolic Species Evolved*. Dordrecht: Springer, 97–116. https://doi.org/10.1007/978-94-007-2336-8_6
- Hoffmeyer, Jesper; Kull, Kalevi 2003. Baldwin and biosemiotics: What intelligence is for. In: Weber, Bruce H.; Depew, David J. (eds.), *Evolution and Learning: The Baldwin Effect Reconsidered*. Cambridge: MIT Press, 253–272.
- Hoffmeyer, Jesper; Stjernfelt, Frederik 2016. The great chain of semiosis: Investigating the steps in the evolution of semiotic competence. *Biosemiotics* 9(1): 7–29. <https://doi.org/10.1007/s12304-015-9247-y>

- Jablonka, Eva; Ginsburg, Simona 2022. Learning and the evolution of conscious agents. *Biosemiotics* 15(2): 401–437. <https://doi.org/10.1007/s12304-022-09501-y>
- Jablonka, Eva; Lamb, Marion J. 2005. *Evolution in Four Dimensions: Genetic, Epigenetic, Behavioral, and Symbolic Variation in the History of Life*. (Life and Mind: Philosophical Issues in Biology and Psychology 7.) Cambridge: The MIT Press.
- Janzen, Daniel H. 1985. On ecological fitting. *Oikos* 45(3): 308–310. <https://doi.org/10.2307/3565565>
- Kleisner, Karel 2010. Re-semblance and re-evolution: Paramorphism and semiotic co-option may explain the re-evolution of similar phenotypes. *Sign Systems Studies* 38(1/4): 378–392. <https://doi.org/10.12697/SSS.2010.38.1-4.13>
- Kleisner, Karel 2022. Semiotic fitting, co-option, and the art of life. *Biosemiotics* 15(1): 31–35. <https://doi.org/10.1007/s12304-022-09484-w>
- Kull, Kalevi 1992. Evolution and semiotics. In: Sebeok, Thomas A.; Umiker-Sebeok, Jean (eds.), *Biosemiotics: Semiotic Web 1991*. (Approaches to Semiotics 106.) Berlin: Mouton de Gruyter, 221–233. <https://doi.org/10.1515/9783110871388-012>
- Kull, Kalevi 1998. Baerian biology: Evolution by means of organisms' interpretation. In: Farré, George L.; Oksala, Tarkko (eds.), *Emergence, Complexity, Hierarchy, Organization*. (Acta Polytechnica Scandinavica, Mathematics, Computing and Management in Engineering Series 91.) Espoo: Finnish Academy of Technology, 197–200.
- Kull, Kalevi 1999. Umwelt and evolution: From Uexküll to post-Darwinism. In: Taborsky, Edwina (ed.), *Semiosis, Evolution, Energy: Towards a Reconceptualization of the Sign*. (Bochum Publications in Semiotics: New Series 3.) Aachen: Shaker Verlag, 53–70.
- Kull, Kalevi 2015a. Semiosis stems from logical incompatibility in organic nature: Why biophysics does not see meaning, while biosemiotics does. *Progress in Biophysics and Molecular Biology* 119(3): 616–621. <https://doi.org/10.1016/j.pbiomolbio.2015.08.002>
- Kull, Kalevi 2015b. Evolution, choice, and scaffolding: Semiosis is changing its own building. *Biosemiotics* 8(2): 223–234. <https://doi.org/10.1007/s12304-015-9243-2>
- Kull, Kalevi 2016. The biosemiotic concept of the species. *Biosemiotics* 9(1): 61–71. <https://doi.org/10.1007/s12304-016-9259-2>
- Kull, Kalevi 2020a. Codes: Necessary, but not sufficient for meaning-making. *Constructivist Foundations* 15(2): 137–139.
- Kull, Kalevi 2020b. Semiotic fitting and the nativeness of community. *Biosemiotics* 13(1): 9–19. <https://doi.org/10.1007/s12304-020-09375-y>
- Kull, Kalevi 2022a. The aim of extended synthesis is to include semiosis. *Theoretical Biology Forum* 115(1/2): 119–132.
- Kull, Kalevi 2022b. The biosemiotic fundamentals of aesthetics: Beauty is the perfect semiotic fitting. *Biosemiotics* 15(1): 1–22. <https://doi.org/10.1007/s12304-022-09476-w>
- Kull, Kalevi 2023. Freedom in living beings: Arbitrariness and the forms of semiotic indeterminacy. In: Biglari, Amir (ed.), *Open Semiotics. Vol. 4: Life and its Extensions*. Paris: L'Harmattan, 79–95.
- Kull, Kalevi; Favareau, Donald 2022. There is umwelt before consciousness, and learning traverses both. *Biosemiotics* 15(3): 491–495. <https://doi.org/10.1007/s12304-022-09513-8>
- Linask, Lauri 2022. Semiosis as choice, learning, and memory. In: Favareau, Donald; Velmezova, Ekaterina (eds.), *Tunne loodust! Knowing Nature in the Languages of*

- Biosemiotics*. (Epistemologica et historiographica linguistica Lausannensia 4.) Lausanne: Université de Lausanne, 195–199.
- Lotman, Juri 1977. The dynamic model of a semiotic system. (Shukman, Ann, trans.) *Semiotica* 21(3/4): 193–210. <https://doi.org/10.1515/semi.1977.21.3-4.193>
- Maran, Timo 2017. *Mimicry and Meaning: Structure and Semiotics of Biological Mimicry*. (Biosemiotics 16.) Cham: Springer. <https://doi.org/10.1007/978-3-319-50317-2>
- Maran, Timo; Kleisner, Karel 2010. Towards an evolutionary biosemiotics: Semiotic selection and semiotic cooption. *Biosemiotics* 3(2): 189–200. <https://doi.org/10.1007/s12304-010-9087-8>
- Markoš, Anton 2016. The birth and life of species-cultures. *Biosemiotics* 9(1): 73–84. <https://doi.org/10.1007/s12304-015-9252-1>
- Markoš, Anton; Grygar, Filip; Hajnal, László; Kleisner, Karel; Kratochvíl, Zdenek; Neubauer, Zdenek 2009. *Life as Its Own Designer: Darwin's Origin and Western Thought*. (Biosemiotics 4.) Dordrecht: Springer. <https://doi.org/10.1007/978-1-4020-9970-0>
- Miller, George A.; Galanter, Eugene; Pribram, Karl H. 1960. *Plans and the Structure of Behavior*. New York: Holt, Rinehart and Winston. <https://doi.org/10.1037/10039-000>
- Monod, Jacques 1971. *Chance and Necessity: An Essay on the Natural Philosophy of Modern Biology*. New York: Alfred A. Knopf.
- Müller, Gerd B. 2012. Synthesis. In: Favareau, Donald; Copley, Paul; Kull, Kalevi (eds.), *A More Developed Sign: Interpreting the Work of Jesper Hoffmeyer*. (Tartu Semiotics Library 10.) Tartu: Tartu University Press, 287–290.
- Noble, Raymond; Noble, Denis 2023. Physiology restores purpose to evolutionary biology. *Biological Journal of the Linnean Society* 138 [online first: 1–13]. <https://doi.org/10.1093/biolinnean/blac049>
- Nöth, Winfried (ed.) 1994. *Origins of Semiosis: Sign Evolution in Nature and Culture*. (Approaches to Semiotics 116.) Berlin: Mouton de Gruyter. <https://doi.org/10.1515/9783110877502>
- Pattee, Howard H. 1969. How does a molecule become a message? *Developmental Biology Supplement* 3: 1–16. <https://doi.org/10.1016/B978-0-12-395541-8.50006-9>
- Pigliucci, Massimo; Müller, Gerd B. (eds.) 2010. *Evolution: The Extended Synthesis*. Cambridge: The MIT Press. <https://doi.org/10.7551/mitpress/9780262513678.001.0001>
- Rodríguez H., Claudio J. 2023. Biosemiotics and evolution. In: Coca, Juan R.; Rodríguez, Claudio J. (eds.), *Approaches to Biosemiotics* (Biosocial World: Biosemiotics and Biosociology 1.) Valladolid: Ediciones Universidad Valladolid, 99–111.
- Rogers, Timothy 2022. *Études in Light and Harmony: An Interdisciplinary Workbook for Creative Dialogue and Discovery*. Toronto: SSRN. <https://doi.org/10.2139/ssrn.3875673>
- Rosen, Robert 1991. *Life Itself: A Comprehensive Inquiry Into the Nature, Origin, and Fabrication of Life*. (Complexity in Ecological Systems Series.) New York: Columbia University Press.
- Rosen, Robert 1999. Mind as phenotype. In: Rosen, Robert, *Essays on Life Itself*. (Complexity in Ecological Systems Series.) New York: Columbia University Press, 96–114.
- Rothschild, Friedrich Salomon 1994. *Creation and Evolution: A Biosemiotic Approach*. (Hes, Jozef P., trans.) Mevasseret Zion: J. Ph. Hes, C. Sorek.
- Saussure, Ferdinand de 1959[1916]. *Course in General Linguistics*. New York: Philosophical Library.

- Sebeok, Thomas A. 1997. The evolution of semiosis. In: Posner, Roland; Robering, Klaus; Sebeok, Thomas A. (eds.), *Semiotics: A Handbook on the Sign-Theoretic Foundations of Nature and Culture*. Vol. 1. Berlin: Walter de Gruyter, 436–446.
- Sharov, Alexei A. 2016. Evolution of natural agents: Preservation, advance, and emergence of functional information. *Biosemiotics* 9(1): 103–120. <https://doi.org/10.1007/s12304-015-9250-3>
- Sharov, A.; Kull, Kalevi 2022. Evolution and semiosis. In: Pelkey, Jamin (ed.), *Bloomsbury Semiotics*. Vol. 1: *History and Semiosis*. London: Bloomsbury Academic, 149–168. <https://doi.org/10.5040/9781350139312.ch-7>
- Sharov, Alexei; Maran, Timo; Tønnessen, Morten 2016. Comprehending the semiosis of evolution. *Biosemiotics* 9(1): 1–6. <https://doi.org/10.1007/s12304-016-9262-7>
- Sharov, Alexei; Tønnessen, Morten 2021. *Semiotic Agency: Science beyond Mechanism*. (Biosemiotics 25.) Cham: Springer. <https://doi.org/10.1007/978-3-030-89484-9>
- Svensson, Erik I. 2023. The structure of evolutionary theory: Beyond neo-Darwinism, neo-Lamarckism and biased historical narratives about the Modern Synthesis. In: Dickins, Thomas E.; Dickins, Benjamin J. A. (eds.), *Evolutionary Biology: Contemporary and Historical Reflections Upon Core Theory*. Cham: Springer, 173–217. https://doi.org/10.1007/978-3-031-22028-9_11
- Tarasti, Eero 2015. *Sein und Schein: Explorations in Existential Semiotics*. Berlin: De Gruyter Mouton. <https://doi.org/10.1515/9781614516354>
- Tarasti, Eero (ed.) 2023. *Transcending Signs: Essays in Existential Semiotics*. (Semiotics, Communication and Cognition 35.) Berlin: De Gruyter Mouton. <https://doi.org/10.1515/9783110789164>
- Thom, René 1968. Comments. (Waddington, Conrad Hal, trans.) In: Waddington, Conrad Hal (ed.), *Towards a Theoretical Biology 1: Prolegomena*. Edinburgh: Edinburgh University Press, 32–41.
- Thom, René 1992 [1989]. An inventory of Waddingtonian concepts. In: Goodwin, Brian; Saunders, Peter (eds.), *Theoretical Biology: Epigenetic and Evolutionary Order from Complex Systems*. Baltimore: The Johns Hopkins University Press, 1–7.
- Tønnessen, Morten 2015. The biosemiotic glossary project: Agent, agency. *Biosemiotics* 8(1): 125–143. <https://doi.org/10.1007/s12304-015-9229-0>
- Turner, J. Scott 2016. Homeostasis and the physiological dimension of niche construction theory in ecology and evolution. *Evolutionary Ecology* 30(2): 203–219. <https://doi.org/10.1007/s10682-015-9795-2>
- Turner, J. Scott 2019. Homeostasis as a fundamental principle for a coherent theory of brains. *Philosophical Transactions of the Royal Society B* 374: 20180373. <https://doi.org/10.1098/rstb.2018.0373>
- Uexküll, Jakob von 1928. *Theoretische Biologie*. (2te gänzlich neu bearbeitete Auflage.) Berlin: Verlag von Julius Springer.
- Vermeij, Geerat J.; Grosberg, Richard K. 2018. Rarity and persistence. *Ecology Letters* 21(1): 3–8. <https://doi.org/10.1111/ele.12872>
- Voland, Eckart; Grammer, Karl (eds.) 2003. *Evolutionary Aesthetics*. Berlin: Springer. <https://doi.org/10.1007/978-3-662-07142-7>
- Waddington, Conrad Hal 1968. The basic ideas in biology. In: Waddington, Conrad Hal (ed.), *Towards a Theoretical Biology 1: Prolegomena*. Edinburgh: Edinburgh University Press, 1–32.

- Wagner, Andreas 2011. *The Origins of Evolutionary Innovations: A Theory of Transformative Change in Living Systems*. Oxford: Oxford University Press. <https://doi.org/10.1093/acprof:oso/9780199692590.001.0001>
- Walsh, Denis M. 2015. *Organisms, Agency, and Evolution*. Cambridge: Cambridge University Press. <https://doi.org/10.1017/CBO9781316402719>
- Weible, Davide 2016. *Exaptation: Towards a Semiotic Account of a Biological Phenomenon*. (Dissertationes Semioticae Universitatis Tartuensis 22.) Tartu: University of Tartu Press.
- Weissman, Irving L. 2015. Stem cells are units of natural selection for tissue formation, for germline development, and in cancer development. *Proceedings of the National Academy of Sciences* 112(29): 8922–8928. <https://doi.org/10.1073/pnas.1505464112>
- Winters, Andrew M. 2018. Introduction: A structural and historical approach to understanding advancements in evolutionary theory. *Biosemiotics* 11(2): 167–180. <https://doi.org/10.1007/s12304-018-9330-2>
- Witzany, Günther 1993. Zeichenprozesse als Bedingungen der Möglichkeit von Leben und Evolution: Zur Notwendigkeit einer Molekularpragmatik. *Zeitschrift für Semiotik* 15(1/2): 107–125.
- Witzany, Günther 2006. *The Logos of the Bios 1: Contributions to the Foundation of a Three-Leveled Biosemiotics*. Tartu: Umweb.
- Witzany, Günther (ed.) 2007. *Biosemiotics in Transdisciplinary Contexts: Proceedings of the Gathering in Biosemiotics 6, Salzburg 2006*. Salzburg: Umweb.
- Yčas, Martynas 1969. *The Biological Code*. (Frontiers of Biology 12.) Amsterdam: North-Holland Publishing.

Weitere Überlegungen zur Semiose in der Evolution: Arbitrarität plus semiotische Einpassung und/oder Mutabilität plus natürliche Selektion

Dieser Aufsatz versucht, einige neuere theoretische Ergebnisse der (Bio)Semiotik zu Arbitrarität, semiotischer Einpassung, Umwelt, Wahl und erweiterter Evolutionstheorie zu einem kohärenteren Ganzen zu kombinieren. Ein solches Modell beschreibt ein Lebewesen durch Subjektivität und die Fähigkeit, Bedeutung zu schaffen, was in Modellen, die auf Reproduzierbarkeit basieren, oft übersehen wird. Wir unterteilen das Konzept von Umwelt in zwei – synchrone Umwelt und verteilte oder diachrone Umwelt. Für letzteres führen wir den neuen Begriff *Umweb* ein. Es wird ein Evolutionsmechanismus beschrieben, bei dem arbiträre Beziehungen, gefolgt von semiotischer Einpassung, in gewisser Weise analog zum neo-darwinistischen Mechanismus zufälliger Mutationen, gefolgt von natürlicher Selektion, sind. Wir diskutieren die Alternativität und Koexistenz dieser beiden radikal unterschiedlichen Wege der Evolution und des Lernens.

Täiendavad kaalutlused semioosi kohta evolutsioonis: arbitraarsus pluss semiootiline sobivus ja/või mutabiilsus pluss looduslik valik

Artiklis püütakse ühendada sidusamaks tervikuks mõned hiljutised (bio)semiootika teoreetilised tulemused, mis puudutavad arbitraarsust, semiootilist sobivust, omailma, valikut ja laiendatud evolutsiooniteooriat. Niisugune mudel kirjeldab elusolendit tähenduse loomise võime ehk subjektiivsuse kaudu, mis jääb replikatsioonivõimest lähtuvais mudel-
leis tihti kõrvale. Omailma mõiste lahutatakse kaheks – sünkroonseks omailmaks ja diakroonseks omailmaks. Viimase jaoks võetakse kasutusele uus termin 'omailmavõrk' (*umweb*). Kirjeldatakse evolutsiooni mehhanismi, milles arbitraarne uuendus koos semiootilise sobitumisega on mõneti analoogsed neodarvinliku mehhanismi juhuslike mutatsioonide ja loodusliku valikuga, ning arutletakse nende kahe radikaalselt erineva evolutsiooni- ja õppimisviisi alternatiivsuse ja kooseksisteerimise üle.