Andrey S. Druzhinin*

Biology of modeling: revisiting Humberto Maturana's philosophy

Abstract: The paper presents modeling as more than interpretation of signs. Although this term is often associated with AI, a method of operating AI, or operating with AI in the human task environment, it may also be understood as the ability of any form of life to realize its living in general. Both these understandings of modeling can be too narrow and too broad to cope with one of the main problems it poses for semiotics and beyond – the elusive explanatory nature of models and/or their misuse in an effort to explain life and its relational ecology. Drawing on Humberto Maturana's biological epistemology, I propose a systemic approach to modeling, as well as elaborating on supersession, a functional and operative substitution of the modeled by the model. In its biological account, modeling is a repetitive and/or recursive way in which the organism arises and operates as a system capable of finding (and distinguishing) itself as a primary source of all happenings in, around, and with it. The system, the composite unity, conserves the composition its components compose and deals with the consequences of this conservation by continuing (projecting) what has been conserved onto the space that affords further conservation.

Keywords: recursion; semiotics; systemic approach; supersession

1 Introduction

There is no other concept more fundamentally important to science than the concept of modeling. Today, the issue of modeling is especially relevant and controversial. When we do tasks that require AI technologies such as large language models, we say we are using models that help us get the answer to the question we are asking. Indeed, model use "is not only a possible answer to our initial question, but already a precondition for asking it" (Hornischer et al. 2020). Something that we accept as an end result of modeling becomes indistinguishable from the process of the same modeling that we engage in prior to the act of accepting. The difference between the models we use in this case, those which are the source and those which are the results of our perception and interpretation, becomes a new meaning that we generate

*Corresponding author: Andrey S. Druzhinin**, MGIMO University, Moscow, Russia,
E-mail: druzhandres@gmail.com

through our perception and interpretation (Yu 2019). We are often unaware that our knowledge is grounded on models and in modeling (Sebeok and Danesi 2000). Therefore, modeling is not only in AI, but is also in nature, as organisms rely on modeling to live; even bacteria that have a facility for nutrient procurement use a basic spatio-temporal model to structure their environment by self-positioning because space and time emerge from the use of models (Metzinger 2007; Sharov 2020).

In his integrative update on the concept of modeling, Hongbing Yu (2021: 651) rejects representationalism, which in most cases prevents us from recognizing the "ever-present presence" of models in our life: "'Reality' as we know it is no more and no less than a model." Yu's update is timely, as the failure to understand model use often leads to model misuse. In particular, criticism is growing over metaphoric models of information in science where it is posited, for instance, that the whole universe is measurable in bits of information, that RNA and DNA molecules code this information and explain life, that natural phenomena are purposeful, that naming is explaining, and that human language is a code of meanings (cf. Kravchenko 2020; Love 2020). As a result, our models of life grow "but an explanation for life itself continues to elude us" (Sherman 2024: 239).

It follows that this elusive character of the semiotic problem puts a lot at stake. The way we use models to understand model use affects the way we live, because living itself is continuous model use. To achieve more clarity in understanding the nature of modeling, we should proceed from the assumption that we are already engaged in the process of modeling what we seek to understand, which is why all the mechanisms we are exploring are already working as part of us and our biology when we explore them. In this paper, I elaborate on a (meta-)systemic approach to modeling along the lines of Yu's integrative, embodied, and process-oriented perspective. In my analysis, I will draw on the philosophy of Humberto Maturana (Imoto 2011; Maturana 1985, 1988, 1995a, 1995b, 2008a, 2008b, 2012, 2016; Maturana and Poerksen 2004; Maturana and Verden-Zöller 2008; Maturana et al. 2016; Yáñez and Maturana 2013), who put biology at the explanatory center of all other phenomena such as cognition, language, and culture. In the sections that follow, I explain his core "bio-logic," in accordance with which I will address the questions of why, where, and how living beings model what they do, as well as examining the natural effect and limitation of modeling called "supersession" (Yu 2021).

2 Maturana's theory of modeling: theory of (a) manner of living

What sets Maturana's ontology apart from other philosophies is its outstandingly comprehensive biological perspective on the nature of being and beyond. The holism

with which he explained how life and the world are enabled, what is knowledge, why we are who and where we are may strike one as annoyingly "unfalsifiable" (Maturana and Poerksen 2004). The reason for this inability to falsify Maturana's theory lies in the inability to think in dual terms and posit an at least imaginative opposite of what he posited. If we are concerned with being, there should be something we may call "nonbeing"; if we talk about living and action, we should keep in mind such constructs as "nonliving" and "inaction." The problem with understanding Maturana's philosophy is that he renders such logical operations impossible. He not only examines being, action, and living – he integrates these notions into a systemic whole that is at the same time meta-systemic because it is what it is, or makes logical sense, as long as there is another's being, action, and living. At the center of his philosophy is *(a) manner of living* – a concept that is difficult to counter with any thinkable antonym. This feature of nonduality and irrefutability is also the main strength of his theory, perhaps, because the empirical nature of our living is nondual and irrefutable. Living cannot be denied because a living being does not need an explanation to live.

Although Maturana never used the term "manner of living" as a distinct concept, he frequently resorted to it in his explanations of other concepts such as autopoiesis, structural determinism, and others. Surprisingly, it is *(a) manner of living* that can encapsulate his biological philosophy in a most succinct way. For one thing, any way of living presupposes a history, because it is the result of previous livings that have been preserved through lineages as a more or less stable realization of this living. At the same time, when we say "somebody's way of living," we presume not so much somebody's living or life as somebody's ability to realize their living or lives. It follows that (a) manner of living is a prerequisite for and the outcome of living, which makes this notion circular, or better, recursive: One's way of living results in itself. What Mike does, is doing, or may do is determined by his manner of "Miking" and nothing else. That is where another important aspect is brought to the fore – that of doings. When Maturana says that "[E]verything that is, everything that happens, is and happens in us as part of our praxis of living" (Maturana 1988: 2), he means that our way of living are our doings that become everything that is (and is not) for us, our only reality. Through doings we realize ourselves. With this important distinction comes an interactional aspect. Doings cannot be performed in a vacuum – there must be some objects with, to, and for which something is done. More than that, such doings make changes to our way of living, laying down the path we follow as we do what we do. Our living inevitably changes our manner of living but to an extent that cannot result in the loss of our manner of living. Such changes are called structural. And finally, manner of living is a relational term that is difficult to use without an attribution like "somebody's," "good," or "a." It appears to be something that should be anchored to a particular living being or a group of living beings who may exhibit

what can be described as *their* manner of living. In fact, if manner of living is accessible to all living beings, *a* manner of living is not. The latter requires a special distinction made by somebody who is part of this manner of living. I need to participate in Mike's life to distinguish his manner of living, otherwise I cannot understand what a manner of Miking is and what is not. This participation brings Mike's manner of living to me as something distinguishable and describable. This participation is a human-specific manner of living called *observation*. All manners of living, or realities, that we can speak of can only be part of our manner of living as observers. It appears that Mike's manner of living is nothing but my manner of living Mike's manner of living.

I believe that Maturana's (a)-manner-of-living biological epistemology can substantiate and illuminate Yu's integrative view of modeling with semiotic modeling as its recursive component. In what follows I elaborate on the why, where, and how of modeling, as well as outlining the phenomenon of supersession by resorting to other key insights that Maturana's philosophical works offer.

3 "Why"-modeling: a need for conservation

Put in Maturana's terms, the natural process of modeling is not a function of a living being and does not occur because of purpose or intention. According to his logic of internal realism (Imoto 2011), living as an autonomous self-regulating process can be realized and organized only if it is *conserved*, which is why a need for conservation is a driving force behind modeling.

Conservation makes it possible for every type of living being to "happen" and be itself instead of disintegrating and falling apart under pressure. While material objects can collapse without the ability or potential to restore themselves independently, living matter seeks to (re)assemble itself from what can exist only if assembled, or conserved. In other words, a stone does not consist of something that can exist only if conserved the way it can and should to make a stone "happen." A stone just consists of something not assemblable. Unlike a stone, a living system is constituted by an organism constituted by molecules. All of these forms of living are necessarily part of something larger and (although not necessarily, as is the case with bacteria) contain smaller parts that can conserve themselves.

I will give an example to demonstrate what is meant by this bio-logic. When we buy a piece of furniture, we get it delivered as furniture *components* that need to be assembled. When we first look at all these components, we may be puzzled at how we will eventually put them together. Knobs, edges, handles, and other parts may lie on the floor as separate objects that our dog can find "interesting" and play with. To us, these components make little but operational sense: They mean what they mean in

their ability to be assembled with each other. We cannot leave them on the floor for the dog to play with, as they are designed to be put together. Little by little, we determine the way these parts can fit with each other and be coherently assembled. Eventually, we assemble them into a composition. There are no components any longer – there is a *composition*. The dog cannot use this composition the way the dog used its components. The composition makes more sense to us, as we understand that we can use it now as a whole piece. Only when we set this composition of furniture components in place, decorate it, and stuff it with items does it become its consequence – a chest of drawers, a piece of furniture for storing things in our room. This chest of drawers is what Maturana would call "a *composite unity*."

This example shows us that what comes as a ready-made piece of furniture is nothing more than an integration of operable elements designed to work together and be assembled by virtue of some operative coherences (joints and fittings) conserved by the manufacturer in the design and construction of these elements. If some joint or fitting fails to be properly conserved and appears to be damaged, the construction of the whole piece is at risk. In plain words, what ensures the realization of wood and metal as a piece of furniture is not mere wood and metal. It is their relations (assemblability of wooden and metal elements) conserved in the form of coherences to be operated with by the assembler. A living system does not need such an assembler – it assembles itself. More than that, unlike furniture, a living system is not designed to self-assemble – it designs itself to self-assemble. Its components (molecules) conserve the results of processes in which they participate and produce coherences that cohere them into a composition (organism) as a qualitatively new entity that conserves, and operates with, coherences that its components can never produce and never conserve but which depend on how its components produce(d) and conserve(d) coherences they produce(d) and conserve(d). In this sense, what makes the organism and what the organism makes is a network of relations that happens as a historical, conservational, unity. A need to conserve what coheres is a feature of living, and living systems "are closed systems (networks of molecular productions) that result in themselves" (Maturana 2012: 158) and specify their own limits (Maturana 1988).

On this view, modeling does not occur because of some genetic code. Rather, genetic code occurs because of modeling (Kravchenko 2020) and, to be more exact, human-specific semiotic modeling. The notion of coding is used to explain the machine-like mapping of nucleotides to amino acids (Sharov 2020) or, in other words, the mysteriously infallible mechanism of conservation. For Maturana, there is neither code nor mystery behind the realization of living and its conservation through lineages. Conservation happens across time not because our cells carry information, but because they are carried by what they carry. Our components are realized by the composition they compose: They participate in processes that

conserve the results of this participation and continue this process or participate in other processes toward another conservation. We living beings are processes that spontaneously continue the process of previous spontaneous processes: Our birth was given by another organism whose birth was given by another organism, etc. There is no coding behind our arising – there are conservational processes that have been taking place. For this reason, a human being cannot give birth to a bird. Similarly, there is no coding behind our being and doing. There is modeling, and it occurs because it occurs within a living system that lives as long as it conserves what it is living and is living what has been conserved. It can be argued that modeling is a conservational realization of living by a living being.

4 "Where"-modeling: domain, niche, medium, and environment

The question of where modeling occurs is closely tied to the question of what is modeled by a living system. If we follow Maturana's logic, any form of life on all levels of its organization must have a space to realize its living. Unlike the living being itself, which is closed and operates as long as its molecular organization is conserved, the living space is open-ended and only affords further conservation. This space remains a stability, or stabilities, yet to be achieved by the organism in its conservation of living. As the organism conserves its living further and further, following the path that these consecutive conservations lay down, these "furthers" are where the organism finds itself on its way to conservation. These are the *spatio-temporal consequences of the organism's conservation.* By being a renewable source of what the organism needs to keep conserving its living, this "furthering" provides a place the organism has taken and is currently taking. In other words, what affords further conservation becomes a space for the organism's modeling, or semiosphere (Zolyan 2022).

How does this "furthering" occur? There are certain biological components such as effectors that account for the movement of cells toward further production and sensors that account for sensitization, i.e. heightened arousal of neurons and their ability to bind and interact. Whereas effectors are the type of molecules that engage in furthering production, sensors can be viewed as emergent from effector-initiated processes, as they are located in nerve fibers (axons) – certain *projections* that cells have to "continue" self-fabrication, or continue themselves. The capacity for projection ("self-continuation," "self-furthering") is specific to all forms of life on any level, as it makes the realization of living possible. When the next point of contact is projected, contact becomes real and further conservation occurs. With mammals in

particular, this capacity manifests itself as a bodily memory to carry the situation forward in a familiar and fulfilling way, such as exhaling after inhaling (Gendlin 1997), as well as to produce a feeling, or a primitive expectancy, of "what happens next" (Johnson and Tucker 2021: 194). Projection can be argued to be a precursor and prerequisite for connectivity and interconnectivity, which some forms of life can reach in their organization.

Effectors and sensors are special neural elements in that they intersect with other nerve cells and change the quality of the latter's activity, thus changing the relations between them and the relational activity of the whole organism. As operational and relational elements, effectors and sensors configure to "constitute the surface" (Maturana 2008a: 109) of encounters between what the organism has conserved and what affords further conservation for it. Maturana uses the word "surface" to point out that sensory–effector configurations ground the projections the organism makes of what it has conserved onto what is affordable for further conservation. This ground determines the length, width, breadth, and other spatial constraints for these projections, "defining a space where the organism can move" and operate (Maturana et al. 2016). The sensory–effector ground also guides such movements and serves as a correlation between a starting point, or point source, of a projection and the resulting impact, helping find commonalities between the two. In other words, sensory–effector configurations define how far the organism can go with its conservational doings, but they can never define what the organism can do. As Heinz von Foerster put it, "[e]ncoded is only 'this much at this part of my body' but not 'what'" (Foerster 2003: 215). The nervous system does not encounter what the organism encounters. The "what" is the consequence of the "how much," and the two have different ontologies. To explain this difference, Maturana resorts to such terms as *domain*, *medium*, *niche*, and *environment*, all of which deal with the "where" of modeling but need further clarification here.

Processes that happen inside our organism give rise to doings that happen to it; what we do as a composite unity is the result of operations of our components. However, we should never read this proposition backwards: What happens to us as a system can never participate in what happens to our sensory–effector components. Our feelings do not happen to/in our nervous system; they are generated by it. In the same way, our doings (behavior) and whatever they entail cannot happen to/in our feelings, because doings are the consequences of what and how we feel. The latter (process) neither needs nor can it have attributes of the former (its result) to happen the way it happens. A living organism and its organismic processes do not operate because of what the organism perceives, does, or imagines. Processes and their products operate in separate, non-intersecting *domains*.

To illustrate and elaborate on this systemic law, I will revisit the analogy between a self-assembling living system and an assemblable piece of furniture. If

there are runner slides, a side mount, and front and rod fasteners lying on the floor, one can operate with them in a certain limited way: We can manipulate them or examine them further, or our dog can play with them. Once we assemble them and establish an operational *coherence*, they open up a new set of operational *affordances*. They become a drawer which we can open, close, slide back and forth, etc. In other words, their coherence opens up a new domain of operations and relations which does not intersect with the domain in which they operated as uncohered (unassembled) components. We could not open a runner slide or front fastener, but we can open a drawer now. The same goes for our experience. Certain configurations of sensoriality give rise to disparate experiences. When experiences cohere, or a certain coherence between these experiences is revealed, it gives rise to a new *set of affordances* for these experiences to happen further, operate in a new way, and be conserved. A new experiential domain arises as a conservational realization of the established coherence. This domain conserves the experiential coherence that, at the same time, gives rise to this domain. One exists as long as the other does; both sustain each other. An example of such a domain is what we can call a situation, context, setting, etc. When we have a meal, our experience of eating configures with that of sitting. It determines a certain coherence that opens up new affordances that should effectively conserve this coherence and be effectively conserved themselves. When we have a meal and sit, we can also talk and enjoy the view to better proceed with our eating–sitting experiential configuration. In this eating–sitting domain, we operate with tables, chairs, TV sets, waiters or waitresses, other companions, etc. and find ourselves having a meal in a kitchen or an eating place. The eating–sitting coherence becomes perfectly consistent with the surroundings where it is realized and conserved, because these surroundings become possible due to this coherence. The situation is "consistent with itself" (Maturana 2012): We do not expect, nor do we encounter half-naked people in a restaurant because the bodily experience of being unclothed does not cohere well with that of eating – it is more consistent with sleeping or swimming, for example. If there are inconsistencies, our experiential coherences will become disrupted and experiential (relational, operational) domains will change and/or expand.

Thus, a domain serves as a permeable boundary between one set of affordances for conservation and another that keeps relations and interactions within the living system safe from disruption. In the flow of living toward further conservation (in the flow of projecting the coherences conserved onto new affordances) or, in other words, encountering its medium, the organism transitions between these domains according to the coherences it establishes between its experiences (Maturana 1995a). This transitioning forms a *niche* – part of the medium that can be occupied by this particular organism only, that interacts with this particular organism only, and that changes with these interactions, specified and realized moment by moment

operationally in the encounters of the organism with its medium (Maturana 1988). Cross-domain transitioning is almost invisible or, in Maturana's terms, obscured from view by the presence of the very organism. This means that the organism and its niche are inseparable and cannot be taken apart, as they form a fluid "ecological coupling" (Maturana et al. 2016) that can be observed as a unity, in the same way as a motion picture can be viewed as a coupling of pictures and their motion. Following the organism's cross-domain transitioning *within its niche* would require another organism (in this case, the observer) to "put on hold" her own transitioning and/or step outside of her own domains of experiential coherences, her own niche, and "live another's life," which is in most cases non-conservational. By analogy, tracing how one picture moves into another would require a viewer to stop viewing the motion picture and use a certain type of software to cut up the video file and thus to become an editor rather than a viewer.

This organism–niche obscurity may account for the fact that in our daily interactions, when we deal with certain people in a familiar setting, for example, in an office, we can struggle to imagine these people acting in another setting and being "other" people. As a result, we may be surprised to learn that our boss is an amateur dancer, because we have not observed him or her transition between the office and dance floor domains of his or her life, as this transitioning has never been performed by us and/or it may be inconsistent with our experience of him or her as our boss (rather than our friend, dance partner, relative, etc.).

While the organism's niche is a "perfect-match" container for the organism and both are a couple, it does not mean that the organism lives in a capsule or is unable to fit into other containers or with other organisms. Drifting toward further conservation, every organism and its niche is detectable, noticeable, usable, and confrontable by at least one other organism–niche unity that happens to come up along the way. Every form of life with the niche in which it is contained is unavoidably part of a larger world where other forms of life present themselves for potential encounters. These encounters are not mutually specified, as is the case with an organism and its niche. They are unidirectional and contingent and fall beyond the agency of one of the participants. A fly crawling on the wall can become our target and be swatted no matter how effectively the fly has conserved its living within the niche where it is crawling. An accident on the road may leave us with lifelong injuries no matter how healthy and happy we once were in/with our interactional niche. The universe "consistent with itself" proves far from universal and consistent when we encounter that part of the medium which surrounds us but which we cannot fully know, live, and control. Maturana calls it an *environment* and points out that it reveals itself as a distinction of the observer.

This important dependence of an environment on the figure of the observer can be explained in two ways. The first explanation draws on the commonsensical

understanding of who an observer is. Normally, somebody who observes watches as something happens and does not interfere. In a more naturalist sense, an observer is an organism that can participate in what the observed organism does not (need to) participate: She becomes part of relations and interactions obscure from view of the observed organism but of which it is part through the spatio-temporal consequences of its doings. It need not know that there is something "out there," but the observer does. In the second account, the observer is an "extracorporeal," semiotic modeler, a modeler of the unknown in that she encounters the unknown without the encounter itself. She assumes that there is something beyond what she encounters in her niche, expanding this niche to her more-than-encounterable environment.

For example, when we watch a film, we become observers of a certain personage that we will never encounter as an embodied creature in our embodied life, but who is encountered in the lives of other personages in this film. Watching the film, we are also ready for the unknown as we explore the intriguing plot twists designed by the film creators as events happening to the personage. As we observe the personage interacting with what she observes (her niche), we also observe interactions in which she does not participate as events happening without her knowing. We observe more than she does in her niche and can know that her friends, for example, are plotting against her in her environment, observable on the screen for us but non-observable for her.

According to this bio-logic of operating across the domain–niche–environment space, we can summarize the ecology of modeling in the following corollaries.

(1) By conserving its living, an organism engages in biological processes that have their spatio-temporal consequences. The processes and their consequences belong to different domains because they afford different sets of affordances for conservation.

(2) The organism's biological processes are a sequence of changes in the closed dynamics of its components (such as DNA) that affords nothing more than has been conserved. The organism's consequential ecological processes afford further conservation toward which the organism moves.

(3) In this movement, the organism projects (continues) itself onto something that it encounters along the way, i.e. its medium.

(4) These projections result in coherent affordances for further conservation, i.e. the organism's niche.

(5) The organism interacts with its niche, which stretches beyond these interactions into an environment.

(6) The organism's environment is incoherently contingent on other organisms. If it is distinguished and controlled by them, they become observers.

(7) The observer sees what the observed organism does not (i.e. its environment) but does not see what the observed organism does (i.e. its niche).

5 "How"-modeling: from repetition to recursion and the rise of the observer

Maturana is overly naturalistic about how an organism models what it does. In a straight departure from realism and finalism of any kind, Maturana describes the way in which modeling occurs in terms of autonomous movement, a movement that does not have a purpose or any external force as its source. This is a *movement that feeds on its repetition* to lead the organism to the manner of living it has.

Autonomy can be understood as a sourcelessness, or groundlessness, of the organism's changes. Conservation toward further conservation creates a spontaneous flow or drift[1] that moves the organism in the direction it cannot choose prior to the movement itself, although in this flow, the organism can act as if it makes choices regarding the direction of its movement. The importance of repetition can be highlighted by drawing on Jean Piaget's constructivist theory, in which he, in alignment with Maturana's work, develops the notion of action schemes and operations (Piaget 1971). Movement becomes operable through repetition because repetition conserves the movement as a scheme (coherence), an effective means to achieve another goal in the future. Repetition makes every movement and action schematic, easily reproducible, recognizable, etc. Repetition also makes movement operative, because it brings new and sometimes unexpected results that need to be conserved as effective. Such a transformative repetition (operation, for Piaget) gives rise to, or reveals, new coherences and new domains. In Maturana's terms, not only is a change brought about, but it is also brought forth. This quantity-into-quality transformation whereby repetition sets off operable novelties is called *recursion.* Maturana illustrates the difference between an ordinary repetition and recursion by comparing them with the movement of a wheel:

> If the wheels of a car turn sliding, the car does not move, it remains in the same place, and the observer sees the turning of the wheels as repetitive. However, if the wheels of a car turn so that their point of contact with the ground changes, and in each new turn the wheels start from a different position […] as a result of this change, the observer sees a new phenomenon, the movement of the car, and considers the turning of the wheels recursive. (Maturana 1995b: 173)

Piaget, by contrast, illuminated the operative power of recursion with the help of mathematics. As we count digits and move on to double digits in our counting, we seldom realize that the latter are the countable (i.e. operable) consequences of the

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1 Although Maturana never makes it explicit, the difference between these two types of movement consists in the scale on which it can be viewed. Ontogenetically, an organism flows from one sensorial change to another, while phylogenetically, these changes are slower-paced and less distinct.

former revealed and established in the process of counting. Instead, we tend to think that each time we deal with double digits, we are counting "separate" units. Similarly, multiplication becomes a recursive result of addition.

Recursion gives rise to reflection that underlies human-specific semiotic modeling when operating results in the distinguishing of this operation, which leads to self-consciousness and "the expansion of the understanding of one's living" (Yáñez and Maturana 2013). In other words, a composite unity begins to operate in the domain(s) of consequences of its operations, with every successive doing building on the results of a previous doing to cohere its doings in the flow of living that these doings create. This type of composite unity is called the *observer*. As the observer coordinates her experiences by establishing a coherence, she uses the consequences of this coordination to coordinate the consequences of coordinated experiences. This flow of coordinations is *languaging*, the behavior of the observer, the only way for her to encounter her medium: observe what she can (interact with her niche) and show herself to another observer (deal with her environment).

The consequential nature of languaging accounts for what Maturana refers to as the *consensual domain* of interactions "generated through living together in the desire of living together" (Maturana and Verden-Zöller 2008). It basically means that some doings of one observer are the consequences of other doings of another observer. An observer's recursive (and reflective) behavior situates her by default in an environment as a niche occupied (or a distinction made) by another observer, which creates a need for more recursion, particularly, for mutual coordinations of behaviors. Finding themselves inside each other's niches (domains of consequences of doings), observers have to "orient to each other's orientations" in the continuous flow of participatory recursive behaviors. Therefore, "everything said is said by an observer to another observer" (Yáñez and Maturana 2013). We human beings are observers whose being is a "being with, in and through others" (Johnson and Shulkin 2023: 44). Our mind is "not in the head, it is in the behavior" (Maturana 1985: 311).

To reinforce the idea that language is grounded in the consequences, not in the causes, of behaviors, Maturana (2008b: 20) reiterates that "the meaning of the words, sentences, signs and symbols is not in the words, but in the flow of coordinations of doings that they coordinate." Interestingly, the same conclusion was made by John Dewey, whose empirical pragmatism appears to have much in common with Maturana's praxis-of-living approach to language:

> Agreement and disagreement are determined by the consequences of conjoint activities. Harmony or the opposite exists in the effects produced by the several activities that are occasioned by the words used. […] Words mean what they mean in connection with conjoint activities that effect a common, mutually participated in, consequence. […] Mark or sound is part of language if it functions as a means of evoking different activities performed by different persons so as to produce consequences shared. (Dewey 1938: 47–53)

Our analytical mind may find it counterintuitive that the content of words arises as their consequence or the meaning of a description is describing, but a simple thought experiment may provide evidence for the semantic power of recursion. Let us imagine strawberries and cream without strawberries and cream. To say that we will imagine nothing is not fair, as we did engage in some imagining and we did evoke some experiences. The words with which we operated did not cancel the experience they evoked, contrary to what we think they do when we say "strawberries and cream without strawberries and cream." What is left after we have said "without strawberries and cream" is an evoked experience that builds on the experience evoked by "strawberries and cream." It is a new experiential and linguistic consequence of operating with familiar experiential and linguistic coherences. So, what is "strawberries and cream" then? It is nothing but an established coherence, a coordination of cooking–eating experience, a way of cooking–eating (together) in the consensual domain. This coherence, coordination, and manner of doing is a mere consequence of our behavior, and this consequence reveals itself as a description "strawberries and cream." This consequence of a behavior can lead to another consequence if it is cohered and coordinated with something else. In this case, it is coordinated with another consequence (description "without") of the same behavior.

6 Supersession of the modeled and the model

It is argued that modeling conditions living beings to live in "ever-present presence" when the modeled world is superseded by its model:

> In any act or instance of modeling, the model supersedes and, in a manner of speaking, is brought to the front for salience, accessibility, and operability, whereas at the same time the modeled recedes and "exists" in the background, inaccessible and inoperable. […] [T]he model is taken to be or lived as the only reality, physical or not. (Yu 2021: 647–650)

In Maturana's biology, the effect of supersession is the natural effect of a composite unity operating *above* its composition operating *above* its components. Contrary to the philosophy of embodiment, for example, Maturana does not look at derivative processes as secondary to what they derive from. In his view, the resulting entity and relations in which it engages are always primary to what relations this entity is composed of. The composite entity cannot operate with its components; it can only operate with the consequences of their composition. We cannot access what is inside the juice we are drinking, nor can we operate with the oranges it is made of – rather we can access and operate with what this juice affords our body, i.e. taste, but the taste of juice, not the oranges that went into it. In the living world, primary ingredients do not matter to the secondary food they go into – they recede into the

background of operability for the person who has the meal. The latter becomes primary, and the former recedes as secondary.

This systemic law of living laid down by Maturana can also be called a law of modeling. It works in the same way for semiotic modeling, where the observer primarily operates with what is observed, or ever-present, rendering the non-observed as secondary. We observers are the primary experiential condition for everything that happens and do not exist prior to ourselves. "Ourselves" is a consequence of our recursive operations with experiential coherences that opens up and sustains a linguistic domain of operations in which we find ourselves and from which we can no longer escape. We are in it; we cannot grow out of it and cannot see ourselves growing into it (Maturana 1988). In other words, we are inside the model that (in our semiotic genesis) has taken us from the modeled further onwards, or higher upwards, and obscures with its boundaries what has been left behind or down there, outside of it and inside the modeled. The model is our only "lived here," and makes it impossible to *be* back or down there anymore; it can only enable us to *go* back or down there *within* its elastic boundaries that can be pushed according to our semiotic efforts of reflection. In a way, the model is like an inflatable walking water balloon that we can stretch in our bodily movements to reach what we can see as reachable from within it. In accordance with this *from-within realism*, or ever-present presence logic, Maturana rejects any speculative attempts to assume or even postulate the non-linguistic existence of observers, or the validity of the modeled without the model: It is not possible to step outside language through language (Maturana 1988: 24), as it defines who we are and what we can do to realize our identity. Language is our inflatable walking balloon that sustains the ever-present presence of everything including ourselves.

Maturana refers to obscurity as one problematic implication of supersession for the observer, whose modeling is recursive and continuously that of modeling of modeling. Every instance of modeling creates (a sense of) ever-present presence both of and within the newly arising model in relation to the modeled. Once we coordinate our doings, the resulting coordination (naming) obscures the doings it coordinates and is (mis)taken for something that replaces them. Indeed, recursion is not about substitution by repetition; it is about expansion from repetition. Walking up a spiral staircase, we at some point lose track of our upward progress because a new successive act of our walking feels very similar to the previous one, as if we are walking in circles. This illusion (or better, perception) occurs because we are looking at things from within our walking where we are walking, i.e. the current result of our walking upstairs integrated in the process of walking. We find it difficult, if not impossible, in the closed spiral staircase to detach walking from where we are walking. To understand how far we have progressed and expanded our vertical

space of walking, we need to stop walking and look down or up the staircase to assess the height we have reached.

Maturana concludes that we are involved with all our sensoriality in making the distinction, as well as in any distinction that we are making (Maturana et al. 2016: 634), both in the process and its result, with the result being a primary perspective for us as it localizes this perspective and is our immediate situation in which we can say or do something. We always live as valid for our living whatever we are living, regardless of the perspective on this living that we can take afterwards and regardless of the opinion of another observer who may look at the flow of our encounters with the medium (Maturana 2006: 94). Recursion makes it our condition of existence that "in experience we do not distinguish between perception and illusion" (Maturana 2006: 94).

With languaging, the consequentiality of ever-present presence is even more elusive. When the observer operates with names and descriptions, she operates with the consequences of what she does with her bodily sensoriality in the domain where these consequences are shared, or mutually participated in, by others. By analogy to walking up the spiral staircase when the observed cannot recognize the difference between walking and its consequences, in languaging the observer falls into the same trap of failing to disentangle observing from the observed. The observer is so engaged in the continuous flow of coordinating behavior that she can attend only to the consequential coordinations of what is coordinated, unable to trace the consequences (names and descriptions) back to her doings (behaviors) back to her sensations. The observer brings herself to the illusion that the consequences of her behavior are the only lived reality, that they are everywhere around and part of every process observed and unobserved. The consequences of behavior are even taken to be part of processes that gave rise to this behavior: "We frequently confuse our description of what we see in the appearance of what happens, [*sic*] with what may be happening that gives rise to such appearance" (Maturana 2008b: 20).

Names and descriptions always appear as the outcomes, results, of any happening of our living in which they participate and which we ultimately replace in and by their appearance. Whatever we do, its consequence appears as a name or description through/in which we deal further with this doing. Whatever we do through a name or description appears as a new (consequential) name or description – the only way for us to go ahead with our languaging. The consequences of our behavior are the only way to deal, and go on, with our behavior. We live in and through the consequences of our living, i.e. language. In such a recursion, the result supersedes, obscures, the process because of participation in other (apparently similar) processes that follow (up) as a result. Names and descriptions give us humans an ever-present presence, replacing everything but their own consequences.

Such a supersession of the model and the modeled affects the observer's living in a way that causes what I call cognitive entrapment (Druzhinin 2025; Druzhinin and Rakedzon 2024a, 2024b). As we do what we do, our flow of living is fluid and ever-changing, wherein our doings instantly *convert* into their consequences, which we observe in and through the doings of others. It requires us to *converse* and be in tune with others (Fomina 2024), make sense of others' senses, or make "con-sense" of our social and cultural medium. However, the way we converse is retroactive rather than proactive as in every process of "con-sense making" we find ourselves involved in, present within, the result already achieved which constrains our way forward and makes us want to *conserve*, re-achieve, it in new processes as if they depended on this result. Our linguistic practices become repeatable patterns (Cowley and Gahrn-Andersen 2022) by which we live irrespective of the ever-new consequences they bring to our living. What we do, every characteristic determined by the operation we perform in distinguishing something, is ultimately projected onto the distinction that acquires the quality of being ever present for us. As Maturana puts it, "every entity, thing or process that we distinguish is the verb or dynamic of doings that the noun with which we name it obscures" (Maturana et al. 2016: 667). This spatio-temporal conflict of conversion/conversation and conservation tendencies is a major cause behind delusions, mass psychoses, and other semantic disorders that have negative ecological implications.

7 Conclusions

In this paper, I undertook an attempt to bring together the biosemiotic concept of modeling and Maturana's biological epistemology. Inspired by Yu's integrative view of modeling as an embodied action that a living being does to navigate the world, I drew a certain philosophical parallel between a naturalist logic of modeling and the bio-logic of knowing developed by Maturana. Although Maturana never used the term "modeling," his theory of (a) manner of living does address in its own right the fundamental questions of why and how an organism relies on models or modeling for its survival, what exactly is modeled, and where the organism models what it does.

In particular, behind any act of modeling is a need for conservation, because in conserving its living, the organism realizes the composition its components compose, sustains the organization of the composition of its components, and continues to be itself as a system. Modeling is a recursive movement toward further conservation, a movement that feeds on its repetition. Modeling occurs when the organism lives in and through its doings, replicating and continuing its biological and behavioral dynamics insofar as it can conserve its manner of living. Every act of conservation

has spatio-temporal consequences that guide the organism's movement toward new affordances for conservation which make up the organism's space of modeling, semiosphere (the medium), in and onto which it projects itself (its doings or/and the consequences of its doings), and where it repetitively or/and recursively encounters its projections. If, in such self-projecting or self-continuation, the organism can move from the consequence of its doing further toward another consequence of another doing without repeating the doings that lead to such consequences, its recursive operating brings the organism to a point at which it finds (distinguishes) itself among others – it begins to operate in a consequential domain of consequential actions, or in a consensual domain of actions. It becomes the observer, a living system that operates in, through, and with language as coordinations of coordinations of actions.

Maturana's theory illuminates "the essence of modeling" called supersession (Yu 2019: 656), when the model supersedes the modeled and provides the organism with the quality of ever-present presence. According to Maturana, it is a natural result, or even law, of systemic living whereby the whole becomes primary to (the relations between) its parts, because everything that is happens to the whole, not its parts, with them making this happening only possible. The side effect of this recursion-based way of living, especially that which we observers have in our linguistic domain of interactions, is that the result (a name or description) obscures the process (naming or describing) that gave rise to it and, in the flow of recursive actions, is taken to be part of this process.

Maturana's insights into biological ways in which an organism comes to live in and by the models it creates are valuable to biosemiotics for several reasons. First, Maturana makes a convincing case for the recursive nature of modeling, which accounts for the difference between existential and semiotic modeling, physical and semiotic "responsiveness" (Sherman 2024), and for the role of modeling in language, meaning, and humanness in general. Second, Maturana leaves no questions as to how we humans should model our modeling but fail to do so: what is primary and secondary in the appearance of every happening, and why life does not depend on the explanatory models we construct but extends beyond the patterns of our experience. Third, the bio-logic of modeling opens up new theoretical ways for investigating the life-sustaining empirical and semiotic relations that emerge as ecological constraints. It presupposes the integration of biosemiotics and ecolinguistics for the purpose of a critical examination of the effects our linguistic actions have on the natural, social, and cultural environment where we live.

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Bionote

Andrey S. Druzhinin
MGIMO University, Moscow, Russia
druzhandres@gmail.com

Andrey S. Druzhinin (b. 1989) has a habilitation in linguistics and is a full professor at MGIMO University (Moscow, Russia). His research interests include cognitive ecology, ecolinguistics, biosemiotics, and biocognitive approaches to language. His recent publications include "Language, nature and entrapped cognition" (2025), "Why language kills: Semantic patterns of (self-)destruction" (co-authored with Tzipora Rakedzon, 2024), *Cancel culture in the flesh: An ecolinguistic view* (co-authored with Tzipora Rakedzon, 2024).