Matter. Energy, Information: http://fdavidpeat.com/ideas/activeinfo.htm
RNA-WORLD: http://nobelprize.org/articles/altman/
H.T.ODUM: Energy Quality- Energy Quality
: http://en.wikipedia.org/wiki/Energy_quality
C.S.PIERCE: http://en.wikipedia.org/wiki/Charles_Sanders_Peirce
ACTIVE INFORMATION SYNCRONISM: http://xoomer.alice.it/a.i.s/Home.html
- What Means Life: in http://www.egocreanet.it

Structural and Semiotic Aspects of Biological Mimicry*

Timo Maran
Tiigi Str. 78, 50410 Tartu, ESTONIA timo.maran@ut.ee

Abstract: Biological mimicry can be described as a structure consisting of two senders (a mimic and a model), a receiver, and their communicative interactions. The distinguishing of three participants in mimicry brings along the possibility to explain mimicry from different perspectives as a situation focused on signal-receiver, mimic, model, or human observer. This has been the foundation for many definitions and classifications of mimicry as well as for some semiotic interpretations. The present paper introduces some possibilities for defining and classifying mimicry and shows them being burdened by structural approach. Proceeding from Jakob von Uexküll's 'Theory of meaning', it is possible to question the common understanding that participants in mimicry are specific species. According to "Theory of meaning", mimicry as any other relation between species is Umwelt-dependent i.e. it is conditioned by meanings and functions present for an animal. Therefore also mimic and model, as entities that the receiver fails to differentiate, are first entities of meaning in one's Umwelt and are not necessarily representatives of some biological species. Uexküllian approach allows us to analyze various examples of abstract and semiabstract resemblances in nature. Based on some examples, the biological notion of 'abstract mimicry' is reinterpreted here as a situation where the object of imitation is an abstract feature with a universal meaning for many different animal receivers. From semiotic point of view, the most common property of mimicry seems to be the receiver's inclination to make a mistake in recognition. This allows describing mimicry as incorporating a specific type of semiotic entity – ambivalent sign, – which is understood as an oscillation between one and several signs depending on the actual course of interpretation.
Keywords: Biological mimicry, Mimicry systems, Classifications, Model, Abstract resemblance.

Biological mimicry can be described as a structure consisting of three participants: a mimic, a model, and a receiver, and their communicative interactions. From the perspective of communication theory, these three participants can be divided between the position of sender and the position of receiver so that the mimic and the model occupy the position of sender as opposed to that of signal-receiver. This tripartite structure of mimicry has been the foundation for many definitions and classifications of mimicry. The relations between the three participants commonly pointed out in mimicry definitions are: 1) similarity between colors, signals or species; 2) deception of one participant, or a participant's inability to recognize the difference; 3) some use or benefit for, or increase/decrease of the fitness of the participants. For instance, British entomologist Richard I. Vane-Wright defines mimicry as follows: 'Mimicry

* The paper was written with the support of grant No. 6670 allocated by the Estonian Science Foundation.

occurs when an organism or group of organisms (the mimic) simulates signal properties of a second living organism (the model), such that the mimic is able to take some advantage of the regular response of a sensitive signal-receiver (the operator) towards the model, through mistaken identity of the mimic for the model'.[1:50]

Distinguishing of three participants in mimicry and their relationships brings along the possibility to explain mimicry from different perspectives, that is, as a situation perceived by either the signal-receiver, the mimic, the model, or the human observer. In early studies mimicry was regarded predominantly from the viewpoint of human researcher and considered rather as a taxonomic disorder or as a fallacious similarity between different species. For instance in 1862 Henry Walter Bates specifies mimicry to be 'resemblances in external appearance, shape, and colours between members of widely distinct families [...] The resemblance is so close, that it is only after long practice that the true can be distinguished from the counterfeit, when on the wing in their native forests'.[2:502,504] Later other perspectives became more eminent. Studies of warning coloration introduced the view of mimicry as a parasitic phenomenon that takes advantage of and at the same time is dependent on normal communication.[3:396-397] Classical studies on mimicry by Jane Van Zandt Brower and Lincoln Pierson Brower launched the understanding of resemblance between mimics and models as a behavioral dilemma for the signal-receiver.[4,5]

In semiotics, the specific aspects which have been emphasized when discussing biological mimicry also seem to depend largely on the researcher's position with regard to the triad of mimic, model and signal-receiver. For instance Thomas Sebeok tends to emphasize the position of mimic, when describing mimicry as an example of iconicity in nature.[6:95-96] From the position of mimic, the process of changing itself or the surrounding environment in order to resemble the model can be considered as a creation of iconic resemblance. This preference is well illustrated by Sebeok's description of the behavior of Asiatic spider who changes 'its surroundings to fit its own image by fabricating a number of dummy copies of itself to misdirect predators away from its body, the live model, to one of several replicas it constructs for that very purpose'.[7:116]

Such approach is in compliance with Sebeok's later theoretical stand: to describe different types of sign in connection with various modeling strategies, i.e. rather from the position of the utterer and sign creation than that of the receiver and sign perception. For instance, in the book 'The Forms of Meaning. Modeling Systems Theory and Semiotic Analysis', iconic signs are defined on the basis of the features of sign creation: 'A sign is said to be iconic when the modeling process employed in its creation involves some form of simulation. Iconic modeling produces singularized forms that display a perceptible resemblance between the signifier and its signified. In other words, an icon is a sign that is made to resemble its referents in some way'.[8:24]

An alternative possibility to analyze mimicry as a semiotic phenomenon is to focus on the position of signal-receiver. Mimicry situation may appear to the receiver very differently from how it appears to the sender. This change is first rooted in a common feature of communication: the emergence of shifts in meanings due to the

asymmetry of the processes of formulating and interpreting, coding and decoding. Theatre semiotician Tadeusz Kowzan has described this as different aspects of sign, which are expressed in the different phases of communication. For instance a sign can be mimetic in its creation and iconic in its interpretation.[9:71] In mimicry, however, the difference of meaning for the sender and the receiver seems to be a more fundamental property. Alexei A. Sharov has explicated mimicry with the term 'inverse sign', where sign has a positive value for the sender ('transmitter' in his terminology), but negative for the receiver. Sharov describes female fireflies, which imitate light signals of other species to attract their males in order to eat them as an example of such inverse signs. Sharov specifies that 'an inverse sign is always an imitation of some other sign with positive value for the receiver'.[10:365]

Similarly to many other cases of animal semiosis, also in mimicry for the signal-receiver the sign relation is formed from the search image or perceived features of an organism (that is representamen), the organism as it is physically capable of being interacted with (that is object), and the meaning connected with the applicability of the organism (that is interpretant). The common denominator of mimicry seems to be the signal-receiver's effort to make the correct recognition in a situation where perceptibly similar objects or organisms may be present.[11:332-334] The difference between the model and the mimic for the signal-receiver may be manifested for instance in the following oppositions: discernible object versus perceptual noise, eatable versus uneatable item, safe versus dangerous organism. The oppositions often go together with diametrically opposite aspirations to react (e.g. catch versus flee). The differentiation of mimics from models depends on many contextual factors (such as the physiological status of the participants, or the specific location of the mimicry situation) and therefore it reappears in each and every act of communication. Because of this it is not possible to conclude whether there are one or two signs or sign complexes involved in mimicry.

In our effort to deal with ambiguous sign complexes, the American semiotician Charles Morris can offer us some guidance. In 'Signs, language, and behavior' Morris introduces the term 'sign family', defining it as a group of signs, which have the same meaning for the interpreter: 'A set of similar sign-vehicles which for a given interpreter have the same significata will be called a sign-family'.[12:96] In accordance with his behaviorist stand, Morris unites signs into a sign family on the basis of a similar behavioral reaction released by the interpreter. In connection with the concept of sign family Charles Morris also points out that a sign may, but need not have only one meaning. He contrasts unambiguous and ambiguous signs: 'A sign-vehicle is unambiguous when it has only one significatum (that is, belongs to only one sign-family); otherwise ambiguous'.[12:97]

The concept of ambiguous signs seems to cover different types of relations between meanings. First, there can be situations where meanings complement each other, and second, there can be situations when different interpretations or meanings are in opposition and exclude each other. For mimicry, the second type of ambiguousness is more characteristic. In its Umwelt the interpreter cannot combine inter-

pretations that correspond to the mimic and the model species but needs to choose between these. Therefore it would be more correct to call such sign combination ambivalent sign instead of ambiguous sign. Ambivalent sign can be described as a sign structure, which fluctuates between one and two signs and where the actual composition and number of signs emerges in the course of interpretation. Such ambivalence has structural importance in mimicry. The perceptual similarity of mimics and models, and the opposition in meanings are components of evolutionary conflict between the mimic and the signal-receiver and an important feature of the communicative regulation between them.

Besides analyzing meanings that different objects obtain in Umwelten of various organisms, biosemiotic research can also focus on diverse relations between animals to discover meaningfulness there. In 'Bedeutungslehre' Jakob von Uexküll describes correspondences between body plans and Umwelten of different animals as counterpoints of meaning. The different Umwelten are mediated by functional cycles, where animals obtain the positions as meaning utilizers and meaning carriers for each other through the perceptual and effectual activity. According to Uexküll these counterpoints of meaning modify entire structures of animal bodies as well as their lifecycles. 'The meaning of all plant and animal organs as utilizers of meaning-factors external to them determines their shape and the distribution of their constituent matter'.[13:37] These meanings can also be mediated by cue-carriers which are distinct from the animal's body, such as the squeaking sound standing for the bat in the moths' Umwelt, but also by a completely distinct organism who acts as a meaning carrier. Here Uexküll presents an example of the male bitterling in which not the female fish causes mating coloring to occur but the sight of the pond-mussel. The bitterlings spawn into the mussel gills where the young fish larvae can later safely grow.[13:55]

Structures in nature that mediate meanings make it possible to consider mimicry in Uexküllian framework of contrapuntal correspondences. With respect to mimicry, Uexküll mentions two examples: the angler-fish Lophius piscatorius who uses a long and movable appendage to lure prey fish, and butterflies that carry colorful eye-resembling spots which scare off insectivorous birds. Uexküll sees these examples as an extension of meaning rules that organize forms in nature. The form shaping of the prey is in these cases not directly connected to the form shaping of the predator, but correspondence is achieved due to some other image or shape-schemata present in the animal's Umwelt.[13:58-59]

Uexküll's 'Bedeutungslehre' opens a significant aspect of relations between species, which should be considered as the biosemiotic ground for interpreting mimicry. That is, the relations between different species, to the extent that these are based on communication, are Umwelt-dependent, i.e. they are conditioned by the meanings and functions present for the animal. Concerning mimicry, the Uexküllian approach means that any deceptive resemblance should be considered first from the viewpoint of the participants' Umwelten. This premise brings along some quite significant consequences for the semiotic interpretation of biological mimicry.

First, it means that the common description of mimicry as a resemblance between two species covers only rather limited cases among many possible similarities. As taxonomic classifications of biological species are the product of human culture and thus specific to the human Umwelt, the animal receiver may distinguish between perceived organisms completely differently. For instance, the taxonomic diversity of bees, bumblebees and wasps as it is described in biology may in flycatchers' Umwelt well form just one group of buzzing and colorfully striped flyers who tend to sting upon catching. If this is so, then Müllerian mimicry can be noticed only by human observer as from the viewpoint of the signal-receiver there are no distinct classes involved.

The second implication is that for the signal-receiver, neither the mimic nor the model needs to be a whole organism but can be just a part of an organism both in spatial or temporal terms or just a perceptible feature. For example, one can say that in a loose sense, the fly orchid Ophrys insectifera as a plant is a mimic, but for solitary wasps who pollinate the flower because of mistaking it for female wasps, the similarity is much more concrete. In the wasp's Umwelt only a blossoming plant can be confused with the mate, and only in the right weather conditions when the pheromone-like smell of the fly orchid floats in the air.

The third implication of the Uexküllian view, which emphasizes the role of meanings in the relations and communication between species, would be an understanding that in animal Umwelten there may exist intense meanings which need not have any direct or strong relations to any specific physical forms. Instead, an animal itself can attribute such meanings to many different objects that match these meanings. Such universal meanings are for instance 'sudden change', 'unfamiliarity', 'possible danger'. Often triggering behavioral responses like halting, fleeing or curiosity to gather more information, these meanings can also become a source for imitation.

Probably the most general level of abstraction is present in warning displays. A well-known defense strategy that uses abstract resemblance is the behavioral adaptation of many reptiles and amphibians to make themselves appear larger in the presence of danger. For instance, upon noticing a snake, the common toad Bufo bufo lifts itself up from the ground and emits strange growling sounds while at the same time its body becomes bloated because of the inhaled air. The aim of this behavior is to become more noticeable and thus to convince the snake that this particular toad does not belong to the group of prey animals. From the viewpoint of mimicry studies, we can say that the toad is mimicking in the most abstract manner the sign complex (model) which in the snake's Umwelt corresponds to animals that are too big to catch.

French zoologist Georges Pasteur excludes such examples from his profound species-based mimicry classification on the grounds that 'the model is not an actual species' and describes these under the terms 'semi-abstract and abstract homotypy'.[14:191] As I indicated before, the question of resemblance to a model not belonging to any concrete species may actually go deeper than just classificatory issues and pertain to the common biological understanding of relations between species, which

focuses on physical forms and properties and largely ignores perceptual features and meanings for the animals themselves.

The explanatory power of biosemiotic view becomes apparent in analyzing the cases of abstract mimicry where the similarity between the mimic and model species is approximate or diffuse. An example of such 'imperfect mimicry'[15] characteristic of Holarctic is the combination of yellow-black warning coloration of many Hymenoptera (wasps, bees, bumblebees) and their imitations on many levels of exactness by hover-flies Syrphidae, but also by some moths, beetles, dragon-flies and other insects. Most biological approaches regard imperfect mimicry as some deviation from the 'normal situation' of drive toward absolute similarity. Such approaches seek to explain imperfectness with specific environmental conditions or ecological relations or try to find some other factor that would compensate for deviation.[16]

From the biosemiotic perspective we can make a principally different suggestion: hover-flies do not imitate any concrete species, but rather a certain combination of colors, which have the meaning of unpalatability or danger for a large group of animal receivers. In other words, the attention of the signal-receiver is focused on the relations between the insect and the conspicuous color pattern with its possible meaning, not on comparing different insects and typifying these. In such case it is not the exact resemblance that becomes decisive, but whether they expose their common color pattern recognizably enough and whether the signal-receiver is familiar with the meaning of the pattern.

In the present paper several communicational and semiotic aspects of biological mimicry have been discussed. The tripartite nature of mimicry systems makes it possible to characterize mimicry from various viewpoints. Focusing on the position of mimic the mimicry could be understood as the example of iconicity in nature, as Thomas Sebeok does it. Focusing on the position of signal receiver, mimicry becomes a dilemma of recognition for the signal-receiver. From the Uexküllian perspective of meaningful relations in nature, mimicry becomes the mediated correspondence between Umwelten. In order to describe mimicry as an integrated, whole semiotic structure, these different perspectives must be taken into account.

References

1. Vane-Wright, Richard I. (1976). A unified classification of mimetic resemblances. Biological Journal of the Linnean Society 8: 25–56.
2. Bates HW. (1862). Contributions to an insect fauna of the Amazon valley. Lepidoptera: Heliconidæ. Transactions of the Linnean Society of London 23: 495–566.
3. Cott HB. (1957). Adaptive Coloration in Animals. London: Methuen.
4. Brower JVZ. (1960). Experimental studies of mimicry. IV. The reactions of starlings to different proportions of models and mimics. American Naturalist 94: 271–282.

5. Brower JVZ, Brower LP. (1962). Experimental studies of mimicry. 6. The reaction of toads (Bufo terrestris) to honeybees (Apis mellifera) and their dronefly mimics (Eristalis vinetorum). The American Naturalist 96: 297–308.
6. Sebeok TA. (1990). Can Animals Lie? In Sebeok, Thomas A. Essays in Zoosemiotics. (= Monograph Series of the TSC 5), 93–97. Toronto: Toronto Semiotic Circle; Victoria College in the University of Toronto.
7. Sebeok TA. (1989). Iconicity. In Sebeok, Thomas A. The Sign & Its Masters, 107–127. Lanham: University Press of America.
8. Sebeok TA, Danesi M. (2000). The Forms of Meaning. Modeling Systems Theory and Semiotic Analysis. Berlin: Mouton de Gruyter.
9. Kowzan T. (1992). Sémiologie du Théâtre. Paris: Nathan.
10. Sharov AA. (1992). Biosemiotics: A functional-evolutionary approach to the analysis of the sense of information. In Biosemiotics. The Semiotic Web 1991, Sebeok, Thomas A.; Umiker-Sebeok, Jean and Young, Evan P. (eds.), 345–373. Berlin: Mouton de Gruyter.
11. Maran T. (2001). Mimicry: Towards a semiotic understanding of nature. Sign Systems Studies 29.1: 325–339.
12. Morris C. (1971). Signs, language, and behavior. In Morris, Charles. Writings on the General Theory of Signs, 73–397. The Hague: Mouton.
13. Uexküll Jv. (1982). Theory of meaning. Semiotica 42(1): 25–82.
14. Pasteur G. (1982). A classificatory review of mimicry systems. Annual Review of Ecology and Systematics 13: 169–199.
15. Sherratt TN. (2002). The evolution of imperfect mimicry. Behavioral Ecology 13 (6): 821–826.
16. Gilbert F. (2004). The evolution of imperfect mimicry in hoverflies. In Insect Evolutionary Biology, Fellowes, Mark; Holloway, Graham and Rolff, Jens (eds.). Cited after: http://eprints.nottingham.ac.uk/archive/00000096/.