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Review article

Explaining and understanding LIFE*

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The biosemiotic model and some suggestions in the light of pragmatics of language

Jesper Hoffmeyer shows us the direction of one of the next fundamental changes of paradigms in the history of science. In his effort to explain life processes in the light of semiotics, he has gone beyond established biological mainstreams. He recognizes that models of explanation, which attempt to explain the organizational structures of all living phenomena by the use of a physicalistic language, are not able to reach their goal of a complete description of life processes.

The paradigmatic change in the perspective of life processes is this: Jesper Hoffmeyer contends that it is the sign and not the molecule that is the basic unit of life. His intention of interpreting life processes in the light of semiotics is an exciting trip through nearly unexplored fields of research. Only biosemiotics has recognized the direction, and one of its most modern exponents has focused his intentions and research results in this book. Besides his excellent model, which opens a new paradigmatic perspective of research consciousness in explaining life processes in future, Hoffmeyer opens a number of new perspectives on traditional problems of research on life-research: the evolution of life; the concept of code-duality, which may equalize the split between the neo-Darwinistic theory of evolution and 'neo-Lamarkism' (evolutionary DNS-growth by chance versus constructive DNS-growth); the evolution of mind; the evolution of language; and many creative explanatory details, which I will only briefly mention here.

'*Signs of Meaning in the Universe*' is not a scientific work in the strict sense, but a scientific essay. This may be an advantage, because the step-by-step approach is not very successful in going beyond paradigmatic

*Jesper Hoffmeyer, *Signs of Meaning in the Universe* (=Advances in Semiotics), trans. by Barbara J. Haveland. Bloomington: Indiana University Press, 1996.

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horizons. But the essay style has a disadvantage, in that there are a number of propositions which are not substantiated for consistent argumentation in scientific discourse.

Hoffmeyer uses a number of misleading anthropomorphisms, which bring the whole explanatory model closer to methods that explain non-human nature by following the pattern of explaining human nature. One of Hoffmeyer's central terms is 'communication'. But his use of 'communication' is sometimes too general. 'Communication' here may be understood by the systems theorist in his version and by the philosopher of pragmatics of communication in his version, both positions being completely incompatible. Sometimes he takes the position of systems theory, which produces deficits in the complete explanation of human communication, and sometimes he uses semiotic patterns of explanation, which reproduce the same deficits.

Therefore, my review shall support Hoffmeyer's excellent model in a critical way. In the first section, I will discuss some implications of Hoffmeyer's concept under the aspect of the theory of science. In the second section, I will discuss examples of the real life-world (*Lebenswelt*), the inter- and the intraorganismic communication processes, and the constitution of meaning.

The intention is to expand upon one of the most interesting paradigms in the history of science: The understanding of life, which is followed by the fundamental (self)understanding of us as human beings. Then we will be able to recognize the wonder of life as a whole, and also to protect it in a very efficient way.

Why anthropomorphisms?

If someone does not take the position that the sign-user is the subject/object of research, it is possible to investigate sign-using processes as a behavior of sign-using individuals. If someone takes his point of view in the light of linguistic behaviorism, then there is no great difference between the sign using of, for example, plants, animals, or human beings. Linguistic behaviorism as a method of explaining specific different situations of interaction within communicative actions remains deficient. Linguistic behaviorism combines 'the symbolically mediated behavioral reaction of the stimulated individual organism' (Habermas 1979: 6) with the model of information transmission ('encoding and decoding signals between sender and receiver for a given channel and at least — partially — common store of Signs' [Habermas 1979: 6]). The intersubjectivity of meanings that are identical for at least two speakers does not even become a problem

in linguistic behaviorism, because intersubjectivity is in this case reduced to extensionally equivalent classes of behavioral properties.

If we talk about recognizing, responding, reminding, and speaking, we know as subjects what the meaning of these descriptions are. We are able to formulate this understanding from observations of non-human organisms, which we try to interpret as similar behavior. I think it would make sense, when talking about semiotic processes in non-human contexts, to place quotation marks around terms like recognition, responding, reminding, speaking, etc. This is not only a problem in Hoffmeyer's book. J. D. Watson also does not distinguish these terms and is under suspicion of using anthropomorphism: the scientifically inadmissible transformation of human characteristics to nonhuman living beings.[1]

What does communication mean?

One of the most important terms in Hoffmeyer's book is 'communication'. Communication happens on every level — between cells, between organisms — but where is the difference between communication of cells, apes, or human beings? I can't find a clear distinction between different forms of communication. It's only clear that all forms are semioses and that there are references to classical-linguistic and linguistic-semiotic points of view as well as those of systems theory.

These positions concentrate their efforts on syntactic-semantic analyses, which are not able to analyze *pragmatic interaction processes*, because they use categories, which are very near to classical metaphysical or ontological positions. Precisely these positions are not able to accept the most important conditions for recognizing communicative processes in their concept, or as Habermas says, 'because they start from the model of the isolated, purposive-rational actor and thereby fail — as do, for example, Grice and Lewis — to reconstruct in an appropriate way the specific moment of mutuality in the understanding of identical meanings or in the acknowledgment of intersubjective validity claims' (Habermas 1979: 8).

On page 46, Hoffmeyer argues, 'But in general there is no way of telling what the purpose is of all the communication taking place on our planet'. In the light of the results of universal-pragmatic communication theory, this is not so correct. Living organisms of all organismic kingdoms are not monads, but live in communities, where communication processes are the only possible way to coordinate behavior and organize the life of communities. We must keep in mind that every possible sign user or interpreter who is involved in sign-mediated interactions does not represent a

monadologic, isolated individual. All of them are members of a species-specific life-world, which shares an evolutionary heritage, and whose behavior is subject to a commonly shared repertoire of rules. This is the purpose of most communication processes, so one can say that without communication processes we lack the essential prerequisites for life or continued survival.

What does 'system' mean?

Hoffmeyer says that his use of the term 'system' is different from the use of 'system' in cybernetic systems theory, because their closed systems and algorithmic decision-making processes are not able to explain principally open interaction processes as they happen in semioses between living beings. What, then, does 'system' mean?

'System' as an ontological term?

'System' in Hoffmeyer's usage could also be named 'entity', which is a quasi-metaphysical description of state. It is also not clear whether 'system' is equal to a hypostasized term of reality (a depicture of perceived reality), or if it is a term within a model of explanation? In the first case, there will be a problem: To explain the conditions of language with (quasi)-metaphysical terms leads into a paradoxical situation, because it would have to be possible to explain premetaphysical conditions of successful understanding (*gelingende Verständigung*) with metaphysical terms. Why does Hoffmeyer not settle on the term 'system' and concentrate on the description of pragmatic interaction and interaction-rules between species-specific individuals in his concept of code-duality?

'System' in the sense of cybernetic systems theory?

In some sentences, Hoffmeyer uses 'system' in the sense of cybernetic systems theory. His position therefore is similar to Manfred Eigen (1975) if the point is the function of the system and the inner logic of this function:

'The point is, though, that in both cases we are dealing with processes that are organized according to a form of logic which reflects the system's (the cell's or the brain's) evolved semiotic function.... What we are looking for is some insight into the practical principles of how the cell or the brain works, i.e., the system's

inner logic, which is, we have seen, an evolutionary product shaped in accordance with the conditions set by statutes at the semiotic level.' (p. 80)

As opposed to traditional systems theory (closed systems as realizations of algorithms), in which 'natural laws' regulate the explications of an implicit logical order of the nature, in Hoffmeyer's concept they are semioses. Language depicts this logical order through the logical structure of the systems (the brain's) communication. If it is, as Hoffmeyer suggests ('system's inner logic'), then the most important characteristic of this inner logic is the syntax. Syntax is the logical depicture of material reality. Meaning as a semantic aspect brings to this depicture intensions of material reality through their special combination in various '*Umwelten*'. The semantic aspect of language is constitued first through a combined sign-sequence which evolved by chance. This sign-sequence becomes meaningful through specific selection processes (the 'not' concept).

Successful explanation of the performative character of speech acts — the aspect of relation and not the aspect of transforming information — between sign-using individuals is not possible with syntax and semantics. This is the deficit of systems theories, and of linguistics and semiotics, too. Communicative competence is the ability to be able to use a number of rules, which are necessary for generating interactive relations between communication partners. This is different from linguistic competence, which is the ability to use a number of rules necessary to generate linguistic expressions.

Languages of science which depict their systems' inner logic (formalizable languages) are incompatible with everyday communication processes. These explanation models based on syntax and semantics as depictures of the inner logic of material reality are not able to describe the full range of sign-mediated interactions. At the base of all formalizable languages and artificial languages of science there is communicative practice, which is historically developed. In this practice, someone can speak about something and move easily between the level of scientific discourse and the level of speaking about this level of scientific discourse, which would be impossible in using a formalized scientific language. In everyday communicative practice, someone can generate interactional processes that are principally not formalizable, for example, in communication processes which are characterized by rule-changing creativity.

I get the impression that Hoffmeyer sometimes equalizes formalized scientific languages with the language used to describe observations. Previous attempts to specify all the rules governing the translation of every term in theory-language into terms of observational languages have been unsuccessful.

The 'not' concept

Hoffmeyer tries to explain the generation of meaning in a process of interaction as systematically narrowing down the probability distribution of semantic alternatives until only a single alternative remains. Narrowing down a probability distribution in this manner can be achieved physically only through irreversible processes. This would be a kind of evaluation of meaning (a selection process). To generate a 'something' one has to eliminate all meanings which are 'not'-this something. If I think about coffee, the 'not' concept is clear and distinct because it is not a tree, not a car, and not a kindergarten. 'So the "not" rule is the very first requirement for making sense of this world' (p. 9).

Shannon has also developed and quantified this concept. Popper's criteria of falsification follows this pattern as well. In generating theories, all possible alternatives were falsified, except for one. Popper's falsification criteria is able to establish an evaluation-of-meaning-scheme for quantifying theories. This classical method of deduction is successful for the generation of quantifying theories. But we are not allowed to mix up two different levels. The one is a criteria of theory of science (developed to substitute the not-very-successful verification criteria of logical empirism and to find a method of evaluation for generating scientific theories rich in meaning) about the quality of quantifying theories. The other should explain how meaning in semioses arises.

So we have a discussable — or, by itself, fallible — model of evaluation in the light of theory of science and not the reality of understanding some information with which the brain recognizes its own form of organization and the inner logic of this form. The 'not' concept tends to interpret the reality of constituting meaning as expression of the logic of a material reality. This is again the point of the depicture theory of cybernetic systems theory. It reproduces the deficit: that it is not possible to explain the pragmatic situation of relation processes by syntactic–semantic rules. For the constitution of meaning, most important are the situations of real interaction between sign-using individuals. Surely, syntactic competence is necessary to build a common shared number of signs. The rules for functioning in everyday communication are learned by sign users in actual relation processes, which follow pragmatic rules of every possible understanding or, as Hoffmeyer says along with Wittgenstein: The meaning of a word is its use. Therefore the 'not' concept is less helpful as a model of explanation of the generation of meaning, because it is a quantifying model for explaining the quality of sign using contexts. To understand an utterance someone has to be involved in an interaction process of a social body, not to know the quantity of the used signs.

To empathize?

A further problem is the model of en- and decoding in linguistics and semiotics that is used by Hoffmeyer. 'Speech demands both a coding mechanism (in the speaker) and a decoding mechanism in the listener' (p. 107). This model functions between strictly isolated individuals:

> In messages between communication partners, one side encodes the news he/she wishes to convey in phonetic characters; the receiver must then decode and interpret the message based on private personal experience. Understanding messages shared between transmitter and receiver is principally possible since a uniform logical form — a universal syntax — lies hidden behind every language. Messages are therefore a priori intersubjective in form and structure, while the interpretation of content remains a purely private matter. (Witzany 1993a: 138)

Therefore, with this concept one can only understand expressions of the partner of communication through empathy which enables the one to 'feel' the private background of the other partner.

In this model, the real process of relationship between interaction partners is also lost. Speech acts in this model are actions of monadic actors and not commonly shared, historically grown everyday practice. Therefore Hoffmeyer has difficulties in explaining the understanding of meanings. So he adopts an older model of explanation in psychology, the model of empathy, 'because it is through empathy that we become human' (p. 133).

But someone does not understand the expressions of a communicative partner (or sequences of behavior which may be interpreted as expressions) because he has an emotional ability of empathy. Someone understands an expression or a speech act if he/she can follow the same rules which are indispensable for a successful interrelation. Speech is a form of action and actions can be understood, if someone understands the rules the action is followed by. This means someone can understand an action, even if the action goes against the rule. So understanding has much to do with acceptance: We understand a speech act if we know what makes it acceptable. That means, we are able to understand a speech act, even if we don't accept it (e.g., an imperative speech act).

The practice of speech acts corresponds to the practice of social interactions. *Every understanding of expressions presupposes the participation of the understanding individual on a practice of social interaction.* This practice of social interaction strengthens the communicative competence to choose the right medium of expression. The use of the right medium of expression is necessary, although my partner in social interaction has the possibility of knowing *what I mean with what I say* (Vossenkuhl 1982). This is a purely

qualitative evaluation and not a quantitative evaluation like the 'not'-concept. And the *rightness* of an utterance is only one of four presuppositions of successful communication where meaning is actually constituted; the others are *comprehensibility*, *truth*, *truthfulness* (Habermas 1985).

If someone uses the model of en- and decoding information units, then he has no other choice than to fill up the syntactic units with private intensions of experiences. The communication partner has more or less the choice of empathy.

The question is, why does Hoffmeyer use models of explanation? Why doesn't he concentrate on the presuppositions of the possibility of formulating models: linguistic and communicative competence. It would not be so difficult to let go of these models of explanation and turn to a semiotic interpretation of the *interrelation processes of interacting populations* and their relevance in the concept of code duality. Then the point of interest is not the inner logic of a system but the presuppositions of successful sign-mediated, rule-governed interactions. Then the main interests are compatible, principal rules of concrete sign use. The situation of sign use is responsible for the constitution of concrete meaning. This I will demonstrate in the following two sections[2] on inter- and intraorganismic communication processes.

The *a priori* of understanding situations (*Verständigungssituationen*) for constituting meaning in the bee language

The language and communication of the honey bee, which has been studied in great detail, can serve as an example for nonhuman language (Frisch 1952, 1953, 1955, 1965, 1971; Lindauer 1975, 1981; Seeley 1982; Heinrich 1981). On the example of two sign-mediated communication processes in the language of northern hemisphere honey bees, I want to demonstrate how, in certain situations, the behavioral context determines the meaning of the linguistic signs used. The bees' ability to interact socially is no doubt genetically fixed. However, the constitution of the specific performance, i.e., of the actual communication process, is contingent on the actual situational demand.

The search for a new home

In the sign-mediated communication process underlying the foundation of a new colony, only scouts participate in the search for a new home. They are the oldest bees in the swarm and have already gathered food

for the parent hive; they are fully experienced with the features of the local terrain. Why do only these experienced scouts swarm out, and not the inexperienced ones as well? Does the flight of the queen cause certain genetic text sequences in the scouts to be expressed, i.e., those that code for and initiate such a behavior? Or does the rule governing the participation of only experienced scouts underlie some other species-specific, intersubjective communication?

The criteria that a prospective hive must fulfill are so differentiated that one can reasonably assume a genetically determined inspection and evaluation behavior. On the other hand, these evaluation criteria clearly do not exist from the onset: they must have been constituted by experience, followed by subsequent genetic fixation. Pragmatic situations formed the evaluation pattern for the combination or creation of genetic sequences that then coded these experiences as text sequences.

No haphazard change or deformation of genetic text sequences can shape the highly differentiated selection criteria for the winter hives of northern hemisphere honey bees: they are simply too rigorous. The failure of the hive selection process to closely match the required hive features can kill off the entire swarm in one winter. The argument that this involves the natural selection of many chance mutations would imply the extinction of all northern hemisphere bee populations before they ever had the opportunity to develop sufficiently differentiated selection criteria for suitable winter hives.

The process by which a potential winter home is scrutinized is itself incredibly complex and exact. The bees pace the entire length and breadth of the new site: no millimeter is left out. This explains why a single bee covers a distance of nearly 50 meters in the course of this inspection, even though the cavity itself is relatively small.

This performance by the bee fulfills a reliable evaluatory function and is part of the overall sign-mediated communication process; in this case it represents an individual contribution. Such specific hive inspection behavior must have been constituted as experience and subsequently become genetically fixed. Some 'factors' in the cell must have coded the specificity of this experience and inserted it into the correct site in the genome. Otherwise the tree hollow would be unable to trigger the expression of the particular genetic sequence that induces the individual bee — at the very time of its arrival there — to reproduce the genetically fixed experiences of past bee generations.

Even this transformation of the scouts' experience into the text-combining activities of enzyme proteins is insufficient to explain why such genetic text fixation provides the next bee generation with suitable hive-selection criteria. After all, the scouts have a different status than

the queen, who gives birth to all bees. While she does move into the new hollow with the swarm, and a genetic fixation of how she experiences this hollow is conceivable, how can she genetically transmit the inspection procedure when she herself did not participate in the inspection? What plausible path exists between the experience of the scouts and the genetic text of the queen? Can one assume a generative linguistic behavior in which experience is initially conveyed interindividually and only later — genetically combined — incorporated into the genetic make-up? One scenario: the scouts impart their experiences to the queen in the form of sign-mediated communication; she represents these internally as stimulation patterns which function as coding criteria that are inserted into the genome in correct relation to existing text sequences. And what might the criteria that govern the transformation into the genetic text be, i.e., which experiences are genetically fixed and which ones are not?

Pragmatic interactions or communication situations which the overall organism experiences in real life apparently determine how code constituting factors of that organism constitute new or altered genetic text sequences.[3] The sign-mediated communication process underlying the founding of a new bee colony also points to numerous other pragmatic situations that must be or, if they are genetically fixed, must have been vital for the evaluatory function. The consultation between scouts about the potentially most suitable new home — in this case, the tail waggle dance — raises the question: what induces bees that have identified a potential site as being less satisfactory to dance less vigorously, and bees that have identified a site as being highly suitable to dance more vigorously and to 'symbolically code' (Todt 1986: 207) the direction and distance of their discovery? What induces the less lively dancers, those who are less convinced of their discovery, to take up the invitation of the more vigorously dancing bees to inspect the site they consider to be particularly suited, especially when this involves repeating the same complex and time-consuming inspection procedure? What subsequently enables these bees to decide in favor of the recommended, inspected, and perhaps more highly evaluated site and to themselves promote this site with an appropriately intense dance? Furthermore, this new decision may itself be temporary, and another, even better home may trigger a renewed inspection process, etc. At any rate, the final decision is a consensus decision by all scouts, all of whom have by then inspected the most highly advocated home. If no consensus can be reached, no decision is taken and the swarm freezes to death at the site of their deliberations during the first cold spell.

Provided that the decision-making process represents sign-mediated communication, then it cannot be of the algorithmic type; rather, it must

be a truly communicative process between conspecifics in a commonly shared life world (*Lebenswelt*). They represent subjects for one another because they use the same linguistic signs in the same sign-mediated communication process to achieve understanding, form associations, and coordinate behavior. The fact that language is involved, i.e., language and not merely a formal procedure, opens the potential for generative and therefore entirely new linguistic behavior. Otherwise, northern hemisphere bees would never have been able to differentiate the necessary sign-mediated communication processes (processes outside the repertoire of southern hemisphere bees). Whereas southern hemisphere bees use behavior to constitute signs with direct indicatory or invitational character, northern hemisphere bees employ movements to constitute and utilize a symbolic sign character for these movements; understanding these signs permits more differentiated messages to be deciphered (messages that even humans can understand, provided that they can determine the rules underlying the use of these movement signs).

D. Todt, a sociobiologist whose research was instrumental in initiating an interdisciplinary dialog with semiotics in Germany, expressly underlines the use of symbols by bees of the northern hemisphere. The specific sign-mediated communication process involved in searching for a home is terminated only when consensus has been reached. The process is completed when a new home (one selected exclusively by scouts) is inhabited and developed.

Food gathering

This marks the onset of the second sign-mediated communication process described above — food gathering. Again, the tail waggle dance is used to convey information. The rules underlying the movement sequences as well as the indication of direction and distance remain the same as in the preceding example. The sequence of signs is also the same. Their meaning, however, is different because they take on new meaning within the pragmatic context of a new communication process. The waggle dance may well be a rule-governed, genetically fixed behavior that is expressed as the need arises: nonetheless, the actual situation in which the signs are used within a population of communicating conspecifics lends meaning to the signs themselves and determines their sequence in a dance.

In addition, the target group addressed by these expressions is not the same as in the preceding case. All foragers, not just the scouts alone, are called upon to search for food sites. One situation-specific feature is responsible for the fact that foragers (and not just scouts) are being

addressed, even though the mode of expression and the utilized linguistic signs are the same as in the previous example in which scouts were prompted to swarm out: only when the dancers carry flower pollen — which is not the case when the task involves searching for a new hive — is the call valid for foragers as well. In the absence of pollen, the foragers do not react to the messages or invitations. Understanding between bees is not limited to dance movements alone. These movements are combined with (the very important) vibratory movements (Kirchner and Towne 1994) of the wings and abdomen, along with the rule-governed use of olfactory signs. This marks the limits of our comprehension of the bee language. Human beings can never hope to progress much beyond a passable understanding of the rules governing the bees' use of language signs: beyond a certain complexity of sign combinations, mastering the specific modes of use would require becoming involved in the bees' communication process as interactional subjects. This inherently transcends human capabilities and points to the limits in the compatibility of transpecific forms of communication; for example, in metaorganismic communication (communication processes between members of different species).

A final criterium

One final pragmatic criterium for the signifying function of the utilized linguistic signs deserves mention: the occurrence of various bee dialects. The same sign (or the same sign sequence) can exhibit slightly different rules of usage in bee colonies that are geographically widely separated yet belong to the same species. In a special case of the Austrian and Italian bees, the form in which the same symbolic (behavioral) sign is expressed can translate into site deviations of several hundred meters. The pragmatic context, in this case the bee colony's actual life-world (*Lebenswelt*), determines the semantic rules according to which this sign is interpreted.

No intra- and intercellular linguistic sign without real sign users: the importance of cellular communities of communication

The genetic code which is fixed in DNA and read, copied, and translated in gene expression gains importance as a genetic text only if real sign-users are available to read, copy, and translate it into the amino acid language. This gene expression, along with all of the related subprocesses, is neither mechanistic nor mysterious and vitalistic. Rather, it is the result of

complex, regulated interactions and highly specific behavior coordination between numerous types of enzyme proteins (Watson 1992).

These enzymes clear the text for reading, implement the copying into the three types of RNA, search the text for superfluous text passages, cut these out, to a certain extent repair damaged sections using rougher and finer techniques (excision and postreplication repair), and complete the entire process of normal gene expression (Howard-Flanders 1981). All enzymatic protein individuals are themselves coded as genetic sequences, yet enzyme proteins themselves always clear genes for reading and thus ensure the reproduction of all necessary enzyme proteins. This allows numerous generations of specific enzyme protein types to exist within the life-span of an organism, beginning at the onset of life.

The technique employed in the reproduction of the enzyme types is the same in all organisms in which genetic texts must be read, copied, and translated into the amino acid language. Every cell of the entire organism stores the complete genetic construction plan in the form of the genome, although only those text passages required for the function of the particular cell association are expressed. This also means that *the specificity of the cell association is decisive for evaluating* those passages (within the total genetic text) that are to be read, copied, and translated. Every organ, i.e., every specific cell association in which specifically associated cells must carry out a function for the complete organism (in a complex coordination with other organs), requires regulated interactions in order to fulfill the demands placed on it by the organism (e.g., raised pulse rate after physical exercise).

Today we appreciate how complex the execution of this sign-mediated communication is in specific communication situations and within specific requirement profiles (Witzany 1993a). The communication between cells of a cell association (organ) is irrevocably limited to this context, i.e., the irreversibility is genetically fixed and virtually guarantees abidance by the rules that govern the reproduction of cell-association-specific progeny: we can be certain that liver cells reproduce only new liver cells.

At the same time, the specific position within a cell association determines the expression of those genes which code for the (punctual) reproduction of a cell *in precisely this specific position. The actual position of a cell in the real environment is the evaluation criterium for the gene-expressing enzyme* to express exactly that segment of the total genetic text which enables the reproduction of a cell in that and no other position (Gehring 1985).

Highly specific cell communication between cells of a cell association further enables the production of proteins required for the various functions (e.g., metabolism function) within the complete organism. The required

proteins are not infrequently produced by very different cell associations via very cell-association-specific communication processes (Witzany 1993b). The rules of these sign-mediated communication processes, both of the intra- and intercellular type, are followed, occasionally even newly constituted, by real users of linguistic signs. They (the rules) are not only structured by the syntax of the genetic text, but also by the real life-world (*Lebenswelt*) of the complete organism; this itself constitutes situational contexts and contexts of experience, or finds itself within such contexts, and is primarily responsible for imposing special tasks/demands on cell associations.

Specific task-accomplishing strategies can be (but need not be) genetically fixed as experiences. This indicates that text-generating enzyme proteins use specific stimulatory patterns of the organism, which are the result of situational contexts in a real life-world (*Lebenswelt*), as a basis for their text-generating activity. Such stimulatory patterns may be neuronal or may function in combination with chemical messenger substances as text-generating stimulatory patterns. Interestingly, evidence for this was provided not by socio- or molecular biologists, but by biochemists (Bonner 1983; Wyles et al. 1984; Wilson 1985). Hoffmeyer's concept of code-duality may be a very exciting perspective for researching especially, in these fields of biosemiotics.

Protein synthesis probably takes place in all organisms in the same manner. Otherwise one would not be able to arbitrarily combine the mRNA, tRNA, and ribosomes of completely different species of organisms in a cell-free environment. The nucleic acid language is governed by a common syntactic law, yet the real life-world (*Lebenswelt*) of protein individuals, of the cell components and cell associations, as well as of those organisms whose life is maintained by these cell associations, determine the use of this language; they initiate the generative, sign-mediated communication processes (i.e., not random mutations due to radiation or mutagenic agents) in which this language is changed, transcended in its meaning, newly combined, or its complexity increased or reduced. Real life-world and the interacting, rule-abiding individuals that constitute them are indirect (via organismic body) co-constitutive for the sentence structure of the genetic texts (Witzany 1993b, 1997).

Without a molecular pragmatism, neither the logic of the molecular syntax nor the molecular semantics that Manfred Eigen (Eigen 1975) deduces from it could be understood; furthermore, their explanation would remain reductionistic. Understanding the language of nature (nucleic acid language) requires a molecular semiotics (Witzany 1993a) that analyses and interprets the molecular interaction processes as sign processes (semioses). This would reverse the omission of the actual sign

users in the intra- and intercellular communication processes and would incorporate their co-constitutive role in the structure of the genetic text and its expression.

This level of insight must be attained before one can legitimately refer to a language of nature: then we are no longer dealing with an explanatory model operating with metaphorical terms, but have an approach that enables us to understand and substantiate the conditions that establish the possibility of living organisms. As long as molecular biology considers language to be an a priori for the evolution of organisms and, ultimately, also of human intellect, it has grasped language only syntactically/semantically. From the standpoint of philosophy of language, we can legitimately refer to a language of nature in the evolution of organisms and in the evolution of human reason only after incorporating the pragmatic dimension of sign utilization and thus including both the real life-world (*Lebenswelt*) of the sign user and an understanding of its life-form.

A further example of how linguistic signs are constituted with meaning *through the pragmatic usage context* is provided by chemical messenger substances whose structure is the same but whose meaning differs in different communication processes. Thus, the same chemical messenger can assume an entirely different messenger function as a hormone than as a neurotransmitter in the communication between nerve cells.

The constitution of immunological memory is yet another example of how the interaction competence of the B-lymphocytes is co-constituted through pragmatic interaction. After successfully warding off an infection, the B-lymphocytes which helped organize the defense remain present in the body as an immune memory. In the event of a renewed infection, the immune response can proceed much more rapidly and more effectively. The immune response itself, however, is not genetically fixed, merely the structure of those proteins that organize the immune response. The immune response is the result of a complex identification and interaction process (Tonegawa 1985). On the other hand, the constitution of the immunoglobulins, in their incredible diversity, is the result of the variable combination of respective DNA sequences.

Here as well, sequence segments are not changed and combined automatically or randomly, but rather through *enzyme proteins with combinatory competence.* Using relatively few, variable sequence regions and following only a few rules, they produce a sheer endless number of *easily distinguished* identification proteins, which help organize a successful immune response. Highly complex interaction forms and mutually complementary communication types (intra-, inter-, and meta-organismic communication), not random sequence mutations, have led to the development of such an immune response competence. If the organization and

structuring of such relatively simple biological processes is controlled by *highly complex enzyme sign processes*, then how much more plausible is the assumption that such sign processes are involved in actual evolutionary processes, in which much more complex symbol processes are required?

Enzyme proteins in particular, which combine and recombine genetic texts, provide evidence for an evolutionarily acquired competence in text processing. More specifically, recombination enzymes identify particular 'recognition' sequences as such and use this ability to carry out combinatory operations on the genetic text; in this manner they cut out semantically significant text sequences from the text assemblage and insert them somewhere else in the assemblage. The sequence combination itself is governed by syntactic rules; the exact nature of their combination is under the influence of pragmatic conditions. *The real-life world* (Lebenswelt) *of the affected cells and molecular structures of a complete organism form the evaluation function which constitutes the actual text combination as a meaning function.*

The metaphor involving the 'language of nature', as applied by molecular biologists, should not be rejected out of hand. Nevertheless, to justify referring to a language of nature in the sense a philosophy of language requires an expansion of the reductionistic language concept of molecular biology. This would enable an understanding of living nature based not on metaphors but on a reconstruction of historical intercommunication situations and forms. The discussion about the language of nature opens new interpretation possibilities for observations in the realm of living nature — avenues that would principally be closed to reductionistic research methods.

Epilogue

These two examples, interorganismic communication and intraorganismic communication, provide some practical examples for the critical remarks that preceded them. I want to emphasize that this review has been written to support biosemiotic research. The critical remarks on some problems in Hoffmeyer's concept in the light of theory of science should lead to a combination of modern biosemiotics and the results of universal pragmatic theory of communication. I am convinced that this combination will enable us to make observations on the central structures of life.

Notes

1. 'T-cell receptors recognize antigens only in association with an MHC molecule', 'Intercellular communication regulates immune system function', and 'The immunoglobulin

superfamily encodes proteins that participate in cell-cell communication (Watson et al. 1992: 305, 307, 309).

2. The following two sections are adapted from Günther Witzany, *Life: The Communicative Structure* (forthcoming).
3. Is this truly Lamarckism? This scenario could be founded on the hypothesis that beneath the three known codes (protein code, regulatory code, structure code) other codes, codes for coding Umwelt experiences, are existent. We don't know such codes, we didn't ask for such codes, and we can't say which criteria are necessary for code-expression. But now there are strong reasons why other codes are existent (Buldyrev et al. 1995; Mantegna et al. 1994).

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