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Beyond Teleonomy and Vitalism: Whiteheads Processual Teleology of the Organism

Today I would like to talk about Whiteheads processual teleology of the organism. I would first like to present the structure of my paper.

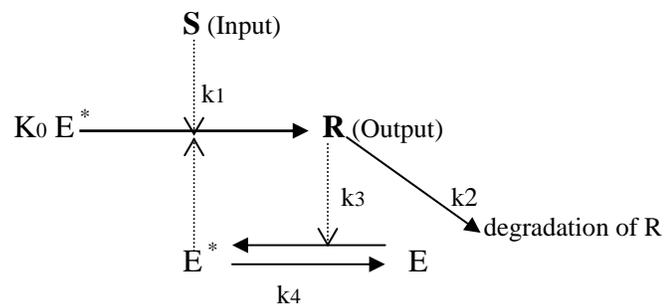
First I will tell you something about teleonomic thought. After that I will move on, to say something about vitalism. My last part is on Whitehead where I will shortly mention the work of Penrose and Hameroff and I will also speak about processual teleology and living occasions.

Although I am not a biologist or rather a system-biologist, but a philosopher, I chose to speak about this subject because I consider this connection very fruitful.

Teleonomic thought

In the 20th century, in the course of the foundation of a science which should be free of all metaphysics, every teleological thought was banned from biology. Therefore today there is talk of “teleology”, if at all, only in the sense of “teleonomy”. This term means that organisms, organs and acts of behavior achieve a final state only because of their own strict physicochemically founded causality.

The modern paradigm of complex thought became, together with the theory of dynamical systems, the main pillar of so called “systems biology”. The research on networks is of crucial importance for the understanding of living events. Signal-networks play a central role in systems biology because they influence metabolism, the form and movement of cells and accordingly the development of an embryo. There is a great variety of signal-molecules in animals like hormones and neurotransmitters. The biomathematical literature describes thousands of signal-networks. The following scheme can serve as a good example for a very simple signal-network or signal pathway:

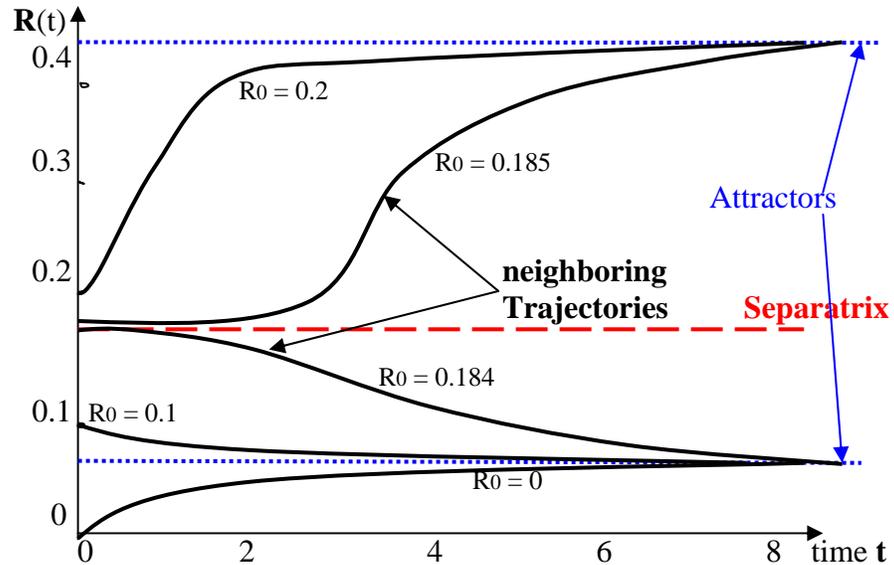


S represents the concentration of a signal-molecule (the input), R the concentration of the molecule generated as the response to this signal (the output), E and E* represent the concentrations of two enzymes, k1, k2, k3, k4 are the so called “control-parameters”,

which influence the chemical reactions and which are taken to be constant, and K_0 represents a constant boundary condition. Of particular interest are the “steady states” in which the concentration of R does not change. The following differential equation is valid for these states:

$$dR/dt = 0, \text{ d.h.: } K_0 E^*(R) + k_1 S - k_2 R = 0$$

This equation has three solutions but only two of them define stable states. This is shown by the following image:



As you can see, there are only two possible final states, that means two attractors. The system necessarily achieves one of them depending on its initial state.

It should be noticed that the behavior of the system changes radically with initial conditions R_0 being between 0.184 and 0.185. The horizontal line running through this spot divides the so called “phase-space” into two separate areas, that’s why it is called “separatrix”. All states which are exactly on the separatrix are absolutely undetermined. As you can see, trajectories immediately neighboring in the direct vicinity of the separatrix diverge strongly over time.

In close proximity of the separatrix, thermal or quantumphysical fluctuations, which are random and undirected, can effect the transition of the systems state from one trajectory to another immediately neighboring trajectory. Thus they are able to decisively influence the development of a network.

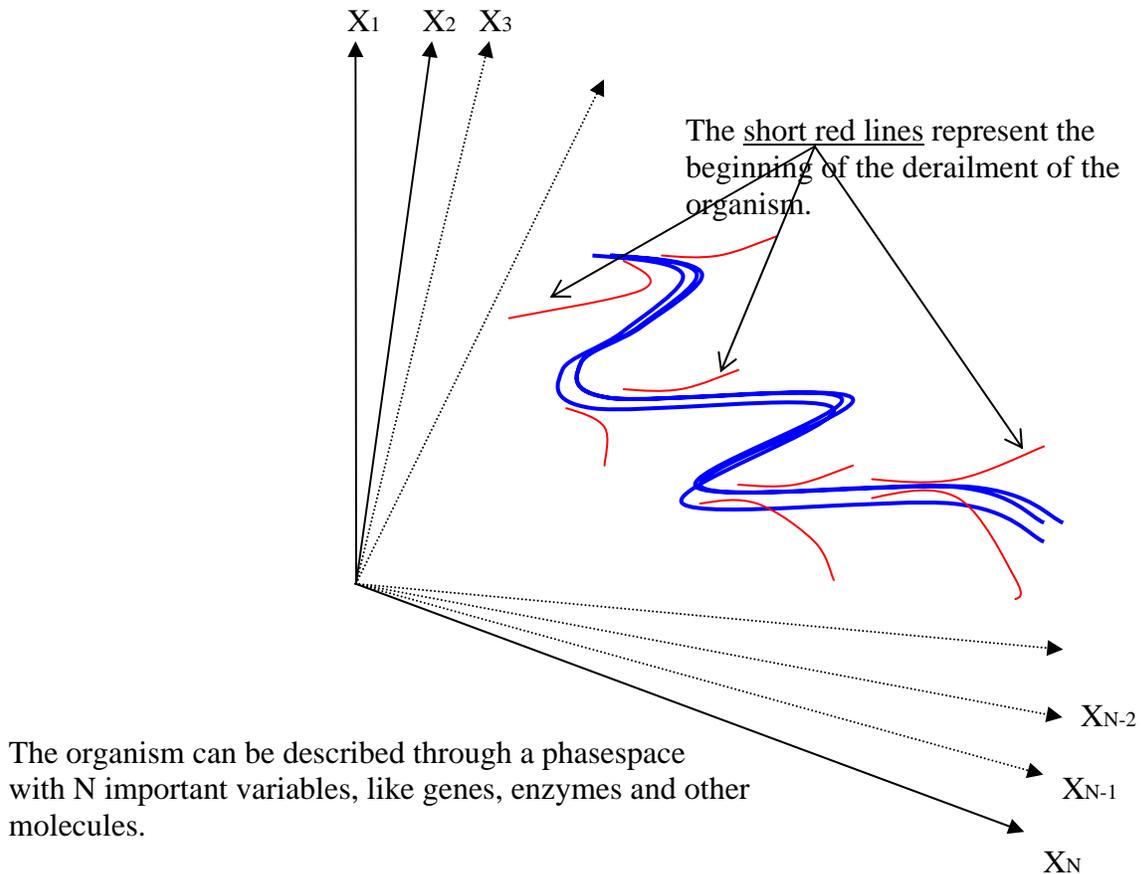
Systems biology knows many possible dynamics of biochemical networks, for example oscillations which are represented by limit cycles. But bistability shows that, even for non chaotic systems, there are areas of indetermination.

It is typical of all models of selforganization – biological and inorganic – with which I am familiar, that they strongly depend on many variables. These variables are preset by

the theorist or experimentalist and the system does not change them. In the example above the change of even one of the variables assumed stable, like the concentration of S and the control parameters, could bring about dramatic alterations of the system behavior.

In real organisms the response (the output) of every signal-pathway influences the input or the control parameters of one or more pathways. The dynamic of all living beings is organisationally closed. This means that even in the simplest bacterium the genetical, metabolic and signal networks form an entire network of huge complexity. In contrast to the above example, all quantities of such a network are determined and balanced by its own inner dynamic. In this sense the entire network is organisationally closed – so it is literally selforganized.

I consider the ontogenesis of a multicellular organism as a really selforganized development which is the result of an organisationally closed dynamic including the organism itself and its immediate environment. But if the organism is considered to be nothing else than a very complex dynamical system, under the realistic conditions of an entirely autonomous selforganization, the possible states of an organism would be much more numerous than system biologists think. A dynamical system so complicated would very often face indeterminate areas in which immediate neighboring trajectories diverge strongly. And – in addition to this – there is no reason to assume that all physical possible states represent states of being alive!



The short diverging (red) lines represent physically possible but not biologically viable states. They depict the derailment of an organism. The question arises: What keeps an organism on trajectories leading to states of being alive (the long blue trajectories), if it is only a very complex dynamic system ruled by efficient causes and no final causes at all? Could a vitalistic factor play this role?

Vitalism

In his work “Generation of Animals” Aristotle says that “energeia“ or “entelecheia” moves onto the unformed embryonal matter and controls the generation of its completed form, so that embryogenesis achieves its “telos”, its end. Of course, the forming entelechy is nothing else than the soul of the embryo, that means an immaterial force which forms its organs.

The first great theoretical challenge to vitalism is the first law of thermodynamics – the law of the preservation of energy. The influence of an immaterial psychical vital force onto the physical world would violate the principle of energy preservation. So a vitalistic attempt to solve the problem stated above (the third graph) is unacceptable.

Whitehead

The foundation of Whiteheadian ontology is the concept of the “actual entity”.

Many current interpretations of Whitehead’s process-philosophy agree that the notion of actual entities is a very inspiring description of the quantum-physical processes of actualization, i.e. of the collapses of the wavefunctions into spatiotemporal localized particles. In this connection the writings of the well known physicist *Roger Penrose* and of the physician and quantum-biologist *Stuart Hameroff* are of special interest. Taking the Whiteheadian philosophy of nature as a basis they argue for the existence of actual entities with mesocosmical dimensions.¹

Processual Teleology

Whitehead regards every concrescence of an actual entity as a “teleological selfcreation” (AI, P. 195/S. 355). But it is not a coincidence that you will seek in vain for the entelechy-concept in Whitehead’s works. He supports a moderate teleology or rather final-causality conception. Central to it is the idea that the crystallization or rather gradual development of the aim, of the telos, for which a subject strives belongs to the essence of every elementary subject. He says:

¹ Hameroff writes about actual entities which manifest themselves in the human brain with a frequency of 40 Hz. Between 10,000 and 100,000 neurons can be involved in these processes (Hameroff, 2003, P. 76-78). Penrose and Hameroff also write about mesocosmical quantum processes which occur in the most simple living beings, like unicellular organisms, and which are not conscious at all (Hameroff, 2003, P. 76).

Process is the growth and attainment of a final end (PR, P. 150/S. 282).

According to Whitehead every becoming actual entity requires an “ideal” (PR, P. 85/S. 170). He calls the “enjoyment” of this ideal the “*subjective aim*” (PR, 85/170). The subjective aim is modified and specified during the process and through it. In this sense, considering a concrescence-process, we may speak of “processual teleology”.

“*Entirely living nexus*“ – “*living occasions*“

Whitehead regards the persisting micro-, meso- and macrocosmic objects as “societies” of actual entities. Only then is a society alive, if it is ruled by a so-called “entirely living nexus” (PR, P. 103/S. 201). An “entirely living nexus” consists only of processes whose mental pole is of exceptional originality.

Whitehead calls the actual entities of which this nexus consists “living occasions” (PR, P. 102, 104). Their originality springs from the fact that they introduce something in the history of a living being that cannot be completely founded on the past of its body and its environment (PR 104/203), like it is the case with teleonomic systems. Only the trace of vividness can be described exhaustively through trajectories – the reason of aliveness escapes every quantifying-metrical depiction, for it is not spatialised, as Henri Bergson would say. The abstract phasespaces of systems-biology are nothing else than special forms of spatialisation. Whitehead acknowledges aspects of organisms which are quantitative and accord to natural laws but he refuses to anchor, never mind to limit, life within these aspects.

Starting from the processual teleology of “living occasions”, one can guess the direction towards a solution of the problem stated earlier in connection with teleonomy: The essence of an actual entity consists in the process of decision between different possible developments. The concrescence-process is completed when all uncertainties regarding the realisation of possibilities are dispelled. Only if this is the case, the new entity becomes a space-time-datum and thus has physical power. Therefore a *single* actual entity is capable of giving a certain direction to an organism, which is at the very beginning of the divergence of neighbouring trajectories, in the phasespace. Concerning this, the writings of the already mentioned *Roger Penrose* and *Stuart Hameroff*, who argue for the existence of actual entities with mesocosmical size, are of particular interest. Because of being actual entities those quantum-events are not random quantum-fluctuations but teleological, meaning directed processes. Thanks to their mesocosmical size they could easily move the state of an organism onto a certain trajectory, which is both physically possible and biologically viable. Thus the organism will stay alive.

Summary closing remarks

- 1) The actual entities of an organism manifest themselves in space-time as quanta of matter and energy; therefore they *are* energy. Thus the process-philosophical approach to life automatically avoids the problems vitalism has with the law of energy preservation.

- 2) The problem of diverging trajectories offers a very fruitful field of application to Whitehead's processual teleology. It confirms that an "entirely living nexus" has the possibility of choice. The divergences of the trajectories, for which I argue, show that for many biological processes there are indeed different possible ways between whom the "living occasions" can take a decision.

The **conclusion** of my paper is:

The *modal* aspect of living beings can be described by system-ontologies and their *actual* aspect by Whiteheadian process-philosophy. Therefore Whiteheadian biophilosophy can integrate the current biomathematical-teleonomical research into its own scheme of thought with great enrichment.

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