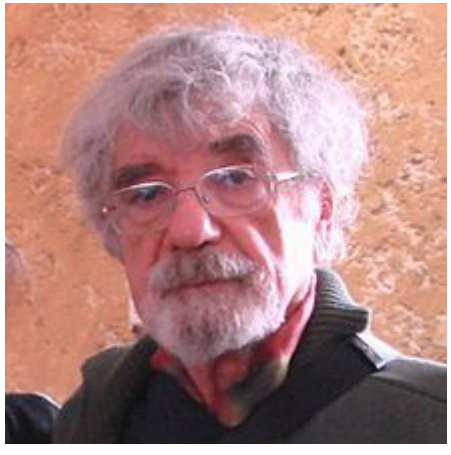
Philosophische Theorien des Lebens

Blogseminar | LMU München | SoSe 16 | Dr. Jörg Noller

Erwin Schrödinger



Humberto Maturana

Francesco Varela

Erwin Schrödinger: *Was ist Leben? Die lebende Zelle mit den Augen des Physikers betrachtet*. Aus dem Englischen übersetzt von L. Mazurczak. München/Zürich (1944; ^{3}1989).

Humberto Maturana/Francisco Varela: *Autopoiesis and Cognition. The Realization of the Living*. Dordrecht u.a. 1980.

Francisco Varela: *On defining life*. In: G. R. Fleischaker et al. (eds.), *Self· Production of Supramolecular Structures*, Dordrecht 1994, 23-31.

Präsentation der Wiki-Artikel

Leitfragen der Sitzung

- *Wie bestimmt Erwin Schrödinger das Leben physikalisch?*
- *Wie bestimmen Maturana und Varela das Leben als Autopoiesis?*
- *Wie verhält sich eine „autopoietische Maschine“ zu sonstigen Maschinen und zum Organismus?*

Erwin Schrödinger: *Was ist Leben? Die lebende Zelle mit den Augen des Physikers betrachtet*. Aus dem Englischen übersetzt von L. Mazurczak. München/Zürich (1944; ^{3}1989).

„Der Ablauf der Lebensvorgänge in einem Organismus zeigt eine bewundernswerte Regelmäßigkeit und Ordnung, die in der unbelebten Materie nicht ihresgleichen findet. Reguliert wird er von einer höchst geordneten Gruppe von Atomen, die nur einen winzigen Bruchteil ihrer Gesamtheit in der Zelle ausmachen. Nach der Auffassung, die wir uns vom Mutationsvorgang gebildet haben, genügt bereits die Verlagerung ganz weniger »regierender Atome« in der Keimzelle, um eine deutlich erkennbare Veränderung der großmaßstäblichen Erbmerkmale des Organismus zu verursachen.“ (110)

„Diese Tatsachen gehören wohl zu dem Interessantesten, was uns die moderne Wissenschaft aufgedeckt hat. Vielleicht erscheinen sie uns doch nicht als völlig unannehmbar. Die erstaunliche Gabe eines Organismus, einen »Strom von Ordnung « auf sich zu ziehen und damit dem Zerfall in atomares Chaos auszuweichen, aus einer geeigneten Umwelt »Ordnung zu trinken«, scheint mit der Anwesenheit der »aperiodischen festen Körper«, der Chromosommoleküle, zusammenzuhängen, die zweifellos den höchsten uns bekannten Ordnungsgrad von Atomverbindungen zeigen. Die Geordnetheit ist hier bedeutend höher als bei den normalen periodischen Kristallen, da jedes Atom und jedes Radikal hier eine ganz individuelle Rolle spielt. Wir nehmen also wahr, daß eine waltende Ordnung die Kraft besitzt, sich selbst zu erhalten und geordnete Vorgänge hervorzurufen. Das erscheint einleuchtend, obgleich wir dabei zweifellos an Erfahrungen mit gesellschaftlichen Organismen und mit Vorgängen denken, die auf der Wirksamkeit von Organismen beruhen. Es sieht also fast so aus, als ob wir uns im Kreise bewegten.“ (110)

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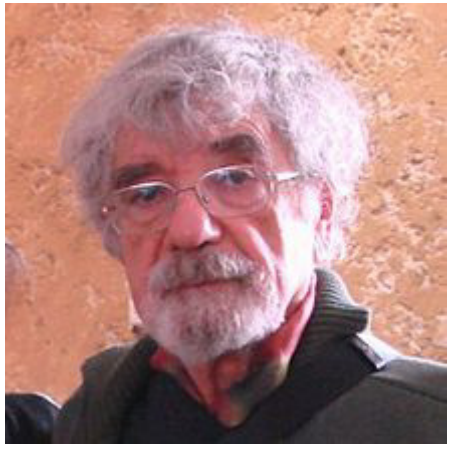

Erwin Schrödinger: *Was ist Leben? Die lebende Zelle mit den Augen des Physikers betrachtet*. Aus dem Englischen übersetzt von L. Mazurczak. München/Zürich (1944; ^{3}1989).

“That living systems are machines cannot be shown by pointing to their components. Rather, one must show their organization in a manner such that the way in which all their peculiar properties arise, becomes obvious. In order to do this, we shall first characterize the kind of machines that living systems are, and then show how the peculiar properties of living systems may arise as consequences of the organization of this kind of machines” (78)

“There are machines which maintain constant, or within a limited range of values, some of their variables. The way this is expressed in the organization of these machines must be such as to define the process as occurring completely within the boundaries of the machine which the very same organization specifies. Such machines are homeostatic machines and all feedback is internal to them. If one says that there is a machine M, in which there is a feedback loop through the environment so that the effects of its output affect its input, one is in fact talking about a larger machine M" which includes the environment and the feedback loop in its defining organization” (78)

“Autopoietic machines are homeostatic machines. Their peculiarity, however, does not lie in this but in the fundamental variable which they maintain constant. An autopoietic machine is a machine organized / as a network of processes of production (transformation and destruction) components that produces the components which: (i) through their and transformations continuously regenerate and realize the of processes (relations) that produced them; and (ii) constitute it (the as a concrete unity in the space in which they (the components) by specifying the topological domain of its realization as such a network. follows that an autopoietic machine continuously generates and specifies its own organization through its operation as a system of production of its own components, and does this in an endless turnover of components under conditions of continuous perturbations and compensation of perturbations. Therefore, an autopoietic'machine is an homeostatic (or rather a relationsstatic) system which has its own organization (defining network of relations) as the fundamental variable which it maintains constant” (78f.)

“Every unity has an organization specifiable in terms of static or dynamic relations between elements, processes, or both. Among these possible cases, autopoietic machines are unities whose organization is defined by a particular network of processes (relations) of production of components, the autopoietic network, not by the components themselves or their static relations. Since the relations of production of components are given only as processes, if the processes stop, the relations of production vanish; as a result, for a machine to be autopoietic, its defining relations of production must be continuously regenerated by the components which they produce. Furthermore, the network of processes which constitute an autopoietic machine is a unitary system in the space of the components that it produces and which generate the network through their interactions. The autopoietic network of processes, then, differentiates autopoietic machines from any other kind of unit.” (79)

“(i) in a man-made machine in the physical space, say a car, there is an organization given in terms of a concatenation of processes, yet, these processes are not processes of production of the components which specify the car as a unity since the components of a car are produced by other processes which are independent of the organization of the car and its operation. Machines of this kind are non-autopoietic dynamic systems” (79)

“(ii) In a natural physical unity like a chrystal, the spatial relations among the components specify a lattice organization which defines it as a member of a class (a crystal of a particular kind), while the kinds of components which constitute it specify it as a particular case in that class. Thus, the organization of a crystal is specified by the spatial relations which define the relative position of its components, while these specify its unity in the space in which they exist - the physical space. This is not so with an autopoietic machine. / In fact, although we find spatial relations among its components whenever we actually or conceptually freeze it for an observation, the observed spatial relations do not (and cannot) define it as autopoietic. This is so because the spatial relations between the components of an autopoietic machine are specified by the network of processes of production of components which constitute its organization and they are therefore necessarily in continuous change. A crystal organization then, lies in a different domain than the autopoietic organization: a domain of relations between components, not of relations between processes of production of components; a domain of processes, not of concatenation of processes. We normally acknowledge this by saying that crystals are static.” (79 f.)

“It is important to realize that we are not using the term organization in the definition of an autopoietic machine in a mystical or transcendental sense, pretending that it has any explanatory value of its own. We are using it only to refer to the specific relations that define an autopoietic system. Thus, autopoietic organization simply means processes interlaced in the specific form of a network of productions of components which realizing the network that produced them constitute it as a unity. It is for this reason that we can say that every time that this organization is actually realized as a concrete system in a given space, the domain of the deformations which this system can withstand without loss of identity while maintaining constant its organization, is the domain of changes in which it exists as a unity, It is thus clear that the fact that autopoietic systems are homeostatic systems which have their own organization as the variable that they maintain constant, is a necessary consequence of the autopoietic organization” (80)

“(i) Autopoietic machines are autonomous; that is, they subordinate all changes to the maintenance of their own organization, independently of how profoundly they may otherwise be transformed in the process. Other machines, henceforth called allopoietic machines, have as the product of their functioning something different from themselves (as in the car example). Since the changes that allopoietic machines may suffer without losing their definitory organization are necessarily subordinated to the production of something different from themselves, they are not autonomous” (80)

“(ii) Autopoietic machines have individuality; that is, by keeping their organization as an invariant through its continuous production they actively maintain an identity which is independent of their interactions with an observer. Allopoietic machines have an identity that depends on the observer / and is not determined through their operation, because its product is different from themselves; allopoietic machines do not have individuality” (80f.)

“(iii) Autopoietic machines are unities because, and only because, of their specific autopoietic organization: their operations specify their own boundaries in the processes of self-production. This is not the case with an allopoietic machine whose boundaries are defined by the observer, who by specifying its input and output surfaces, specifies what pertains to it in its operations.” (81)

“(iv) Autopoietic machines do not have inputs or outputs. They can be perturbated by independent events and undergo internal structural changes which compensate these perturbations. If the perturbations are repeated, the machine may undergo repeated series of internal changes which may or may not be identical. Whichever series of internal changes takes place, however, they are always subordinated to the maintenance of the machine organization, condition which is definitory of the autopoietic machines. Thus any relation between these changes and the course of perturbations to which we may point to, pertains to the domain in which the machine is observed, but not to its organization. Thus, although an autopoietic machine can be treated as an allopoietic machine, this treatment does not reveal its organization as an autopoietic machine” (81)

“If living systems are machines, that they are physical autopoietic machine is trivially obvious: they transform matter into themselves in a manner such that the product of their operation is their own organization. However we deem the converse is also true: a physical system if autopoietic, is living. In other words, we claim that the notion of autopoiesis is necessary and sufficient to characterize the organization” (82)

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“I want to start by declaring that I think understanding organisms and the living is possible, that defining these terms in a satisfactory manner is not a utopian dream, and that we even have a good deal of the road already charted. But this under a fundamental condition: that the autonomy of the living is highlighted instead of forgotten, as it has been for a long time” (23)

“Proposition 1: Organisms are fundamentally the process of constitution of an identity.” (23)

“a. By identity I intend here a unitary quality, a coherence of some kind. It is not meant as a static structural description (it is a process) nor as carrying a mentalistic or psychological connotation (it is identity in a generalized, not personalistic, sense). b. The nature of this proces is always one of operational closure (Varela, 1979), that is, a circular reflexive interlinking process whose primary effect is its own production. c. It is this operational closure which gives rise to an emergent or global coherence, without the need of a "central controller." Hence, the identity I have in mind here is non-substantially localized and yet perfectly able to generate interactions.” (23)

“Proposition 2: The organism's emergent identity gives, logically and mechanistically, the point of reference for a domain of interactions.” (24)

“a. The living identities are produced by some manner of closure, but what is produced is an emerging interactive level. The interactions have relevance and consequences for the unitary identity, although mechanistically all interactions (say, chemical encounters) occur both at the component level and the unity level. b. The configurations of a level of interaction for the entire unity create a perspective from which an interaction can occur. In other words, this perspective is the source of informational, intentional, or semantic values to all living organisms. c. This entails that living systems bring forth significance: organisms are autonomous, not heteronomously directed.” (24)

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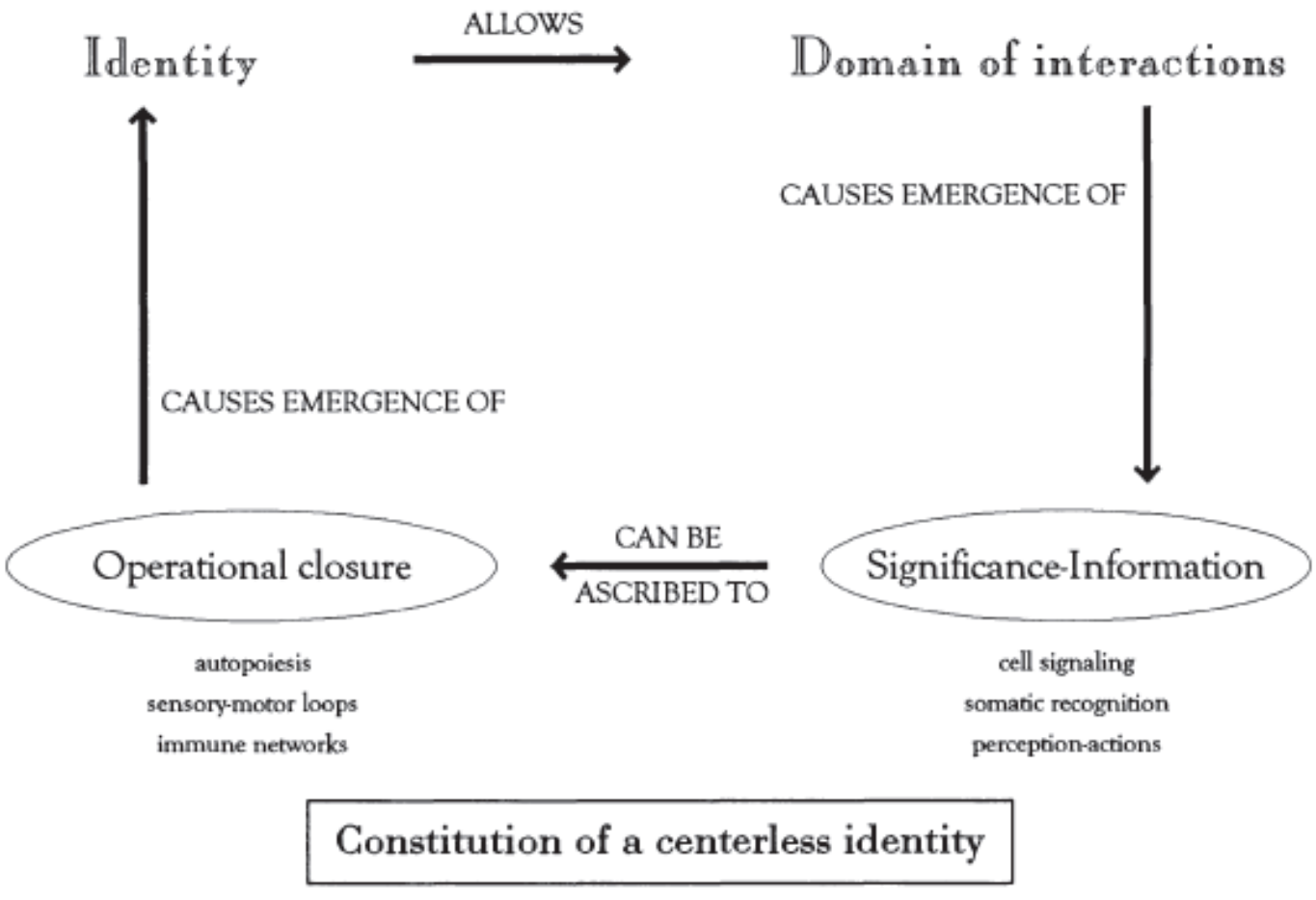

“I warned the reader that my position was going to be an explicit one, which has the advantage that it can be open for discussion; I will illustrate how we can put it to work below. A second advantage is that we can point to two basic falsifiable consequences of this theory of the organism: 1. No adequate understanding of life (minimal or at the level of multicellular organisms) will be feasible unless and until the appropriate identity mechanism is identified. In particular, this predicts that all functionalist approaches will fail. (This is already quite apparent in the current study of the origin of life.) 2. The role of historical coupling and contingency is not secondary but inseparable from organismic existence, since identity is not "substantial" or "abstract." In particular, there cannot be a disembodied theory of life, and the work of simulations can only be a help not are-constitution.” (25)

“Cellular Identity: In this section I take the general scaffolding presented in the first section and put it to work toward a fundamental aspect of living systems: the definition of a minimal form of life, that is, the identity mechanism of the cellular unity. Clearly, defining "life" in general is not what I am after, since it is a multifarious phenomenon. What I am saying is that there are regional identities for life and that we can well have a good take at the minimal level. This is, of course, not the only one we need to understand, but other levels will not concern us here” (25)

“The bacterial cell is the simplest of living systems because it possesses the capacity to produce, through a network of chemical processes, all the chemical components which lead to the constitution of a distinct, bounded unit. Without being trivial, the attribute 'living' in the foregoing description must address the process that allows such constitution, not the materials that go into it or an enumeration of its properties.” (25)

“But what is this basic process? Its description must be situated at a very specific level: it must be sufficiently universal to allow us to recognize living systems as a class, without essential reference to the material components. Yet at the same time it must not be too abstract--that is, it must be explicit enough to allow us to see such dynamical patterns in action that are in the living sytems we know on Earth, those potentially to be found in other solar systems, and eventually those we create artificially.” (25)

“Contemporary cell biology makes it possible to put forth the characterization of this basic living organization--a bio-logic--as that of an autopoietic system [from Greek: self-producing] (Maturana & Varela, 1973; 1980). An autopoietic system--the minimal living organization--is one that continuously produces the components that specify it, while at the same time realizing it (the system) as a concrete unity in space / and time, which makes the network of production of components possible. More precisely defined: an autopoietic system is organized (defined as unity) as a network of processes of production (synthesis and destruction) of components such that these components: i) continuously regenerate and realize the network that produces them, and ii) constitute the system as a distinguishable unity in the domain in which they exist.” (25 f.)

“Thus, autopoiesis attempts to capture the mechanism or process that generates the identity of the living and thus to serve as a categorical distinction of living from nonliving, not more, not less. This identity amounts to self-produced coherence: the autopoietic mechanism will maintain itself as a distinct unity as long as its basic concatenation of processes is kept intact in the face of perturbations, and that unity will disappear when confronted with perturbations that go beyond a certain viable range (a range that depends on the specific system considered). Obviously, all of the biochemical pathways and membrane formation in cells can be immediately mapped onto this definition of autopoiesis.” (26)

Schöne Ferien!