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Biological Individuation Revisited

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Abstract

We explore the concept of "biological individuation" (l'individuation biologique) which was introduced by a French philosopher: Simondon in his doctorate thesis initially defended in 1958 and entitled "l'individuation à la lumière des notions de formes et d'information. More precisely, we will focus on the assertion according to which within the living, there is "a regime of internal resonance" that requires "permanent communication" and through which individuation is acting on itself. We will provide a formal representation of this assertion.

A Philosophical Scheme

"Individuation" is a philosophical scheme, not a scientific concept. Contrary to the traditional analytical way of thinking, French philosophers of science like Simondon [1] consider that all good philosophical problems cannot be reduced to scientific ones. On the contrary, philosophy of science is a reflection that starts from epistemological and metaphysical problems engaged by scientific theories *without any attested scientific solution*. One of these problems is: what is a biological organism? Trying to analyse the problem, Simondon [1] comes back to the distinction between an individual and individuation. The suggestion is to start with the assumption that an individual *is the result* of individuation, and not with the classical philosophical claim according to which, individuation is *a property* of an individual. It means that what is coming first, ontologically speaking, is a process: the process of individuation. Simondon [1] is not a philosopher of being, like Plato, Aristotle, Leibniz or Russell. It is a philosopher of becoming, like Heraclitus, Nietzsche, Bergson or Whitehead.

Physical Individuation

Second, "individuation" as a philosophical sketch starts from physics of phase transition. Why would it be so? Because even in a first order phase transition, like crystallisation, we will get two properties that strictly speaking are not properties of an object. In physics, objects are generic. The same laws determine them and they depend on the same symmetries. One object can be replaced by another one without a need to change these laws. However, in physics of phase transition we deal with the very distinction between closed and open thermodynamic systems. Following Simondon [1], "openness" is not the property of an object. It is also not the property of a system understood as a "whole". Simondon [1] calls "Openness" a *topological* property. It can be compared with the principle of *penetrable entities* invented by Whitehead[1]. It means that an entity can also be considered as a property of another entity, from which it depends. Thus, for *theoretical reasons,* the list of its properties is never closed.

An open thermodynamic system subjected to changes in pressure and in temperature is under external constraints, symbolized by control parameters from which the structure of the system depends [2]. Of course, one would reply that an open S system submitted to such constraints coming from its environment E can be integrated in an extended system E+S=S*, and also S*+E*=S**, so that at the limit of such iterations we will find the whole universe. But this conceptualization doesn't work, because the universe cannot be considered as a whole that can be an element in another whole. There is no external constraints, no environment for the universe! Consequently and as already emphasized by Gibbs[2], equations of a thermodynamic flow describing a phase transition can only be local ones. They cannot be global. Strictly speaking, they have no value for the universe and *a fortiori* not for Mother Nature, because there is no thermodynamics flow from which the universe depends! Let's call R_1 this inside/outside property, characterizing an open system as a local one. It is clear then that such a system is not a conservative one. There are two reasons for this. First, because it is not *completely* defined by the list of its elements or by the list of all the internal structural constraints from which these elements depend. On the contrary, such a system, by the presence of R_1, is structurally incomplete. The whole is defined as a part of another whole. As individual, it is already individuated, and what is coming first is not the individual. It is individuation. However, for certain critical values X of the control parameters in the flow thermodynamic equations such open system can suddenly change of phase. For instance, in a first order phase transition, it can crystallise. In a second order phase transition, like ferromagnetism, there is a net magnetisation. And through this change of phases, *a new global constraint can emerge*, from which all elements of the system (and sometimes also its surrounding) depend. Let's call "agency" such a constructive property. Crystallisation or magnetisation, are emergent properties in this way of thinking. Simondon [1] means that such global properties emerge *diachronically* during time, *so that what a system is, is also what it does.* The relation between "what it is" and "what it does" explains what it is. And again, "what it does" cannot be considered simply as a property that could be explained by what it is. Therefore, such a system is not an object. *It is nothing but a process.* It means that no formal description of S at an instant (T_0) would be complete, as expressed in the formal calculus by the high level of non-linearity of the flow equations that cannot be directly integrated (i.e., solved exactly). Let's call R_2 this constructive

[1]See Debaise [3].

[2]Here there can be no mistake in regard to the agreements of the hypotheses with the facts of nature, for nothing is assumed with that respect [4].

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property, through which, for certain value of its external constraints, the whole system S *changes of shape*. On one hand, this change is determined by a condition, and by the flow equations that describe its behavior. But on the other hand, it is neither a property of an object, nor the property of the system. It is a property of a system, firstly considered *as a process, because through such a change, time cannot be described as an independent variable*. For this second reason, such an open system is not a conservative one. The French philosopher will call R_2 a "chronological" constraint. What the system *is* afterwards is not what it *was* before, since its shape has irreversibly changed through *a temporal symmetry breaking*.

Biological Individuation

Following Simondon [1], individuation of the living constantly "amplifies itself without being stabilized" (2013, p 152). Vital individuation takes place extending the critical states of material individuation until it attains its stable equilibrium. Then, "the living conserves within itself a permanent activity of individuation" (2013, p 27). It is "not only the result of individuation, like the crystal or the molecule, but it is the theatre of individuation: not all of the activity of the living is concentrated at its limit, such as with the physical individual (2013, p 27). Within the living, there is "a regime of internal resonance" that requires "permanent communication" and *through which individuation is acting on itself*. Thus, a living thing is obviously not a mere machine, since in biology there is "an individuation by the individual" (2013, p 28). In other words vital individuation "is doubling by perpetual individuation, which is life itself" (2013, p 27). Our suggestion is to call this strange assumption: *the doubling condition*.

What would it mean exactly? Let's take a biological system. There is also an inside and an outside. For instance, there is no cell without membrane. And since the system has a metabolism, it is an open one. So what could be the difference between a cell and a crystal? Schrödinger [5] has already posed this old question. Schrödinger's [5] answer was that crystallisation is nothing but "an order coming from disorder". In a crystal growth the same pattern is indefinitely repeated, like in the wallpaper of our washroom. On the contrary, a living organism is a masterpiece of embroidery, say a Raphael tapestry" which shows "an elaborate, coherent, meaningful design" (1944, p 5). Thus, even if there is nothing in biology that cannot be explained by physics, physics need to be *extended to* the principle of "order by order". This principle already includes a doubling condition. However, in Schrödinger's [5] mind, it concerned only the nature of the information contained in the aperiodic crystal. This information was supposed to have a second order semantic meaning. He spoke of "a "microcode" bearing "an hereditary code-script" (1944, p 21). On the contrary, in Simondon [1], it is individuation that gets a second order meaning**.** How can we manage this?

In a recent paper by Miquel and Hwang [6] we imagined a mapping, by which R_1 and R_2 operators are applied to themselves in a recursive equation, so that at the limit they get a semantic meaning. Let's write that:

$$R_N = (R_1 R_2)^N \quad (1)$$

And let's assume now that at the limit, we find the following fixed-point equation:

$$R = \Phi_1 \Phi_2 R \quad (2)$$

« R » will be the so-called doubling condition. In our opinion, « R » is « the left wall of complexity » invented by Gould in order to express the symmetry breaking between simple physics and biology [7]. At the limit R of the previous mapping (1), we assume that "openness" or "connectivity" and "agency" are nothing but internalised semantic properties Φ_1 and Φ_2 (2).

By « Φ_1 » we mean that an organism does not simply depend on boundary conditions, like in a phase transition. The environment is a part of its own world. In other words, the identity of an organism is *co-constructed* [8]. We must abandon the classical misleading dichotomy between internal factors coming from the organism's developmental history and external environmental factors like natural selection, as if developmental and evolutionary constraints could be *independent* ones. Finally the co-construction of each organism is a rule of its dynamic, an optimum to which every biological system goes. Of course, it explains why every biological system is *extremely context dependent*.

By « Φ_2 » we mean that the "agency" of an organism is not simply due to favourable circumstances, like certain value of control parameters for critical systems. On the contrary an organism internalizes its own agency, as an attractor of its dynamic, as an optimum, a rule, initiating by this way *a continuous flow of temporal symmetries breaking*.

We think that such a rule can be connected with the Darwinian principle of "descent with modifications" [9] that is *a non-conservative* one. What this principle means first, is that there is no biological individuation without a *decoupling between ontogeny and phylogeny*. Strictly speaking, biological reproduction never achieves "identical products" for an evolutionary reason: *the presence of variations in inheritance by which it will be modified*, and whatever such variations could be. It also means at a pure *ontogenic* level, that the default state of an organism is not quiescence. It is proliferation with variation and motility [10].

In other words, a biological system is not changing one time. It changes all the time, through the structural decoupling between his phylogeny and his ontogeny. Thus, its criticality is not point wise, like in classical phase transitions. Following Bailly [11], Longo and Montévil [12], we can assume that it is *an extended one*.

Conclusion

"Biological individuation" is a philosophical drawing, a painting. It is not a scientific assumption. What we suggest here is a *philosophical equation*. It is neither a modelling, nor a formula that can be integrated as such in a scientific theory.

In our view, it can be compared with the "microcode" imagined by Schrödinger [5], or with the "natural selection" assumption proposed by Darwin. However, it doesn't mean that it is not useful. If this sketch fits, it will feed the scientific research, and it can finally later generate a scientific theory.

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