revista CONTROVÉRSIA
ISSN 1808-5253
UNISINOS

LIVING IS A TELEOLOGICALLY-CONSTITUTED MODE OF BEING: REVISITING THE DEEP CONTINUITY BETWEEN LIFE AND MIND

DOI: https://doi.org/10.4013/con.2025.213.10

Jeferson Diello Huffermann

Pesquisador de Pós-doutorado e professor colaborador do Programa de Pós-graduação em Filosofia da Universidade Federal do Rio Grande do Sul. Bolsista do Programa Institucional de Pós-Doutorado (PIPD) da CAPES.

jeferson.diello@gmail.com

https://orcid.org/0000-0001-8986-1912

ABSTRACT:

The argument brought forward is that living is a teleologically-constituted mode of being, that all living systems are cognitive in a basal sense. Teleology and its place in the study of the living is where I start. Then I explore two specific theories of minimal individual life that strongly link living and cognizing in a way that opposes brain-centered views of cognition, classical autopoiesis and the enactive approach (EA). It can be shown that they part ways when the topic is the naturalization of purpose. I argue that minimal life according to the enactive approach requires sense-making and agency. The enactive conception of cognition as sense-making is then explained. From minimal requirements and constraints for life, I explore operational definitions of both cognition and agency that set empirical and theoretical agendas for further inquiry. But the notions of agency and cognition that one arrives at by looking at minimal requirements for life are generalizable in such a way that their characterizations do not imply minimal individual life. Agency and sense-making can be instantiated in other self-organizing systems; a cognitive agent does not need, in principle, to be a biological individual. The final section reinstate what I think to be the cornerstone of the deep continuity between mind and life, not the reduction of mind to life, but the opening up of life to the flexibility, historicity and path-dependency that we unproblematically attribute to mind and culture.

KEYWORDS:

Cognition. Teleology. Life-mind continuity. Agency. Autopoiesis.

VIVER É UM MODO TELEOLOGICAMENTE CONSTITUÍDO DE SER: REVISITANDO A CONTINUIDADE PROFUNDA ENTRE VIDA E MENTE

RESUMO:

O argumento apresentado é que viver é um modo de ser teleologicamente constituído, que todos os sistemas vivos são cognitivos em um sentido básico. A teleologia e seu lugar no estudo dos seres vivos é o ponto de partida. Em seguida, exploro duas teorias minimais específicas da vida individual que vinculam fortemente vida e cognição de uma forma que se opõe às visões de cognição centradas no cérebro: a autopoiese clássica e a abordagem enativa (AE). Pode-se demonstrar que elas divergem quando o tópico naturalização do propósito. Argumento que a vida mínima, de acordo com a abordagem enativa, requer produção de sentido e agência. A concepção enativa da cognição como produção de sentido é então explicada. A partir de requisitos e restrições mínimas para a vida, exploro definições operacionais de cognição e agência que estabelecem agendas empíricas e teóricas para investigações futuras. Mas as noções de agência e cognição às quais se chega ao analisar os requisitos mínimos para a vida são generalizáveis de tal forma que suas caracterizações não implicam vida individual mínima. Agência e produção de sentido podem ser instanciadas em outros sistemas auto-organizados; Um agente cognitivo não precisa, em princípio, ser um indivíduo biológico. A seção final restabelece o que considero ser a pedra angular da profunda continuidade entre mente e vida, não a redução da mente à vida, mas a abertura da vida à flexibilidade, historicidade e dependência de uma trajetória que atribuímos, sem problemas, à mente e à cultura.

PALAVRAS-CHAVE:

Cognição. Teleologia. Continuidade vida-mente. Agência. Autopoiese.

1 Introduction: purposiveness in living systems, the two strategies after Kant

Following Kant's considerations about natural teleology in his *Critique of the Power of Judgment* (1790/2001), it seems one would have to understand organisms as intrinsically teleological. To know them, organisms have to be treated as intrinsic purposes. The basic insight is that teleological descriptions and worse, explanations, would be an ineliminable component of biological understanding. This was the main legacy of Kant's philosophy to biological theorizing (GAMBAROTTO; NAHAS 2022).

Discussing Kant's claims and arguments is not in the scope of this paper. Regardless, I highlight Kant's legacy because of its controversial and multidirectional impact in contemporary biology. Philosophers and theoretical work in biology have used those ideas in different strategies to deal with the challenge of placing purpose and purpose-related concepts in the life sciences. Gambaroto and Nahas (2022) identify two main families of strategies to deal with the challenge of teleology in Biology following Kant's footsteps, strategies that employ a *heuristic* use of purposiveness and a *naturalistic* attempt to reintroduce purposes in the life sciences in a reputable way. The majority of strategies are heuristic ones and they see Kant's views as valuable research tools for producing mechanistic explanations of organisms. In thinking of the organism *as if designed*, one learns a lot about the mechanisms behind their operations by analogy with what would be the intentional and unintentional normative constraints of it. According to the heuristic position, we can apply normative constraints to organisms, as one does with artifacts, without literally thinking that organisms are the product of design. The 'as-if' instance would be a crucial insight about the appropriate methodology of the life sciences that eschews for good vitalism and the quasi-religious notion of intelligent design. In the 20th century one sees the rise of neo-Darwinian approaches that naturalize 'biological function' through explanations in terms of natural selection; such attempts exemplify well the heuristic family of strategies. Examples of such strategies include the 'etiological' account of biological function (WRIGHT 1973) and Mayr's notion of 'teleonomy' (1974/1985). Purpose-talk in biology would be a shorthand and still be in a pre-scientific discursive register. The adequate explanations would refer to measurable mechanisms. In 21th century theoretical approaches to cognition, one finds something in this vicinity in the *Technological Approach to Mind Everywhere* (*TAME*) championed by Michel Levin (2022).

Another grouping of approaches sees in Kant's conception of intrinsic purposiveness the jumping off point to a radically new way of thinking about biological systems that aims to reinstate teleology into a legitimate concept in the study of nature. In most physical systems what is seen is the parts constraining the whole, the whole is the effect produced by operations of its parts. However, organisms would be such that their parts are what they are and their function is what it is because of constraints of the whole into the parts. In an organism the parts do not precede the whole in any meaningful way, a living brain is what it is only in the context of its biological unit (a bee, a dog, a human). The Enactive Approach (EA) (THOMPSON 2007; DI PAOLO *et al.*, 2017; DI PAOLO*et al.*,2018) has this second more ambitious agenda of naturalizing teleology as a theoretical project (see esp. WEBER AND VARELA 2002; THOMPSON 2007). Both classical autopoietic theory and the enactive approach have been grouped together and misunderstood with regards to the relation between biology and philosophy of mind. This paper shows how the two approaches differ and how they go about in their naturalization of the mind, which begins with considerations about criteria for minimal life and the problem of the purposiveness of living, but does not reduce itself to it.

The problem of the purposiveness of living is often tied to questions about how widespread is cognition as a phenomena. Few would deny that some form of goal-directness is necessary for cognition, some would insist that it sufficient for a minimal or basal type:

> Compare the response of a plant's roots to water with the response made by a teaspoon of salt. The roots change their direction of growth; the salt dissolves. Both of them change—both "respond," in a sense. But the response of the plant is more than something that just

> happens. It is also a change in accordance with the role that water has for the plant's vital projects, for its continued existence and reproduction. A pathway has been built in the plant—with hormones and genes involved—that brings it about that the detection of water has this particular effect. The teaspoon of salt does not engage in minimal cognition. (GODFREY-SMITH 2020, Chapter 8).

Godfrey-Smith's idea is that salt is not cognitive, but plants are. I agree with him. Water has importance or salience for plants in a way not accounted for in strictly dispositional terms, contrasting with phenomena such as the solubility of salt in water. The notions of vital project, purpose and cognition, in a naturalistic approach, serve the research goal of better understanding this difference. Following Pamela Lyon's work (2006; 2020; LYON*et al*., 2021), I prefer to use 'basal cognition' for the goal-directed, context-sensitive, basic sensing and responding of organisms, already present in unicellularity and possibly expanded with multicellularity. Many would describe what follows as an account of "proto-cognitive", "quasi-cognitive" or "minimally cognitive" behavior. The difference is mostly in vocabulary, the more substantial disagreement would be about some intuitions regarding the notion of cognition itself.

2 Minimal life and purpose: autopoietic theory

In the inventory of concerns of theoretical biology, unsurprisingly, it is the concern for the definition of Biology's topic, *life*. But not the main concern of this subfield of Biology, there is no crisis in the life sciences resulting from the lack of such definition. Researchers can successfully study the characteristics and processes found in recognizable individual living systems and their aggregates without it. Most of the advances in 20th century evolutionary theory were possible due to focus on the molecular level, by studying life and how it changes over time. The interaction of one macromolecule and its components (DNA and their genes) with other molecules (mainly RNA and amino acids), in a process of replication and mutation over time.

Amongst other things, the Enactive Approach is an attempt to return to the organism as the unity of relevance to the studies of both mind and life. The "return to the organism" *ethos* is also present in ground-breaking work from the second half of the twentieth century onward (WADDINGTON, 1966; GOULD; LEWONTIN 1979; LEWONTIN, 1985; 2001; WALSH, 2015). One cluster of proposals of definitions of life are *minimal life* theories of the individual living systems. The assumption of theories in this cluster is that the relevant features of life are found in the simplest exemplar one can find, the living cell. Examples of such theories are the theory of autopoiesis (MATURANA; VARELA 1980; 1987) and Robert Rosen's (1991) metabolism-repair (M,R) systems. Rosen's (M,R) systems and the theory of autopoiesis are in general agreement on modeling how systems can be open to matter and energy exchanges with its surroundings in a way to maintain their self-production over periods of time. In principle, those systems could lack reproduction and mutation and still be considered alive. Of course, life as we know it is widespread and diverse. Life perhaps came into existence in an isolated place on the planet, but rapidly took over the globe and it changed Earth significantly. To say that life begets life is an understatement. However, self-production is at least conceptually prior to reproduction and heredity. Reproduction presupposes individual self-production (MATURANA; VARELA, 1980, 96–111). In the more specific case of autopoiesis, the main concern found in Maturana and Varela (1980) is in how to comprehend cognition as a widespread biological phenomenon: '*Living systems are cognitive systems, and living as a process is a process of cognition*. This statement is valid for all organisms, with and without a nervous system' (13, italics in the original).

For Pamela Lyon (2006), autopoiesis can be classified as one of the main theories that exemplify and inspire a *biogenic approach* to cognition. In this type of approach:

> the principles of biological organization and the requirements of survival and reproduction present the most productive route to a general understanding of the principles of cognition. Cognition, whatever else it may be in the future, is naturally a biological process and a biological function.[...] what is it that biological systems do such that they might require cognition? (LYON, 2006, 12)

Theories that follow a biogenic approach are concerned with what cognition does for organisms and how it does it. For classical autopoietic theory the biological function of cognition is maintaining *autopoietic organization* through constant *changes in structure* (MATURANA; VARELA, 1980). The organization of a system is the set of relations of its constituent parts that authorize saying that the whole system belongs to a certain class, is what gives the system an identity recognizable by an observer. Having four legs, a back and allowing sitting can be said to be one of the organizations that make something a chair for us. The relevant contrast of 'organization' is the notion of 'structure', the actual realization, the concrete components (the organelles of a cell, the organs of an animal) and its relations that physically constitute a system of a given class. Different organisms are different overall structures that belong to (or instantiate) the class of autopoietic organization. Actual autopoietic systems come in a variety of physicochemical structures and the same structure can instantiate different organizations beyond the basic autopoietic one (my cat is a self-producing living organism, but it is also an animal and a mammal). The cases of changes of structure where the organization is invariant more immediately noted by us happen in development, as the one that goes from embryo to newborn kitten and eventually to adult cat. However, structural change with invariant organization is the absolute norm in cellular life.

Recent empirical research on molecular biology has confirmed what long was suspected, that *self-organization is the main principle of cellular architecture* (NICHOLSON, 2019). Let's break down this claim. Cellular architecture research studies what determines the shape, size and relative location of the parts of the cell in relation to one another. A popular assumption of the field was that the genome was the main determining factor. That turns out to be wrong. Self-organization, the other aspect of the claim introduced, in this context refers to a form of molecular organization. Groups of molecules in a self-organizing metastable configuration generate what is called a "dissipative structure": a structure where the components interact nonlinearly staying in a far-from-equilibrium state that maintains itself in this state by constantly expending energy and exchanging matter with the surroundings. Self-organization requires the grouping of molecules to be open to material exchange, they rely on constant exchange of matter to replenish the material that composes this organization. Turns out that the way in which most subcellular components reach a dynamical metastable state is by self-organizing.

The term "structure" has connotations of static, materially closed configurations of matter (a building, a crystal, a mountain, a computer). Self-organizing structures are nothing of the sort, another way of describing them is as *temporally extended stabilized processes dependent on fluxes of matter and energy for their stabilization*. Another example of self-organized structure is a tornado, water and other molecules circulating in the air form a pattern that reciprocally constraints the water and miscellaneous molecules into a macroscopic configuration (the spiral/vortex structure visible with the naked eye). A tornado exists as long as the climate conditions are met, its existence depends on a certain molecular flow. Cells and many of its components are structures in the sense that tornadoes are structures, not in the sense that transistors are structures. We are vortexes of activity all the way down.

In the case of the cell 'Strictly speaking, there is no genetic blueprint for the cellular architecture' (NICHOLSON, 2019, 112). As far as the current science can tell, there is no single component functioning as a set of instructions in cell organization. Nicholson (2019) argues against DNA-centric views of cellular behavior, what the cell *does* cannot be said to be completely encoded in the genome. Such discoveries in cellular architecture are a good example of how structural changes can preserve organization. Looking at the evidence coming from molecular biology and employing the autopoietic organization-structure distinction, one can conceptualize *basic living systems as unities that maintain invariant organization through constant changes in structure occurring at different scales*. The theory of autopoiesis claims that autopoietic organization is the organization of the living. Autopoiesis is both necessary and sufficient for life, as we are going to see, this point is contested by enactive thinking. The assumption is that the components and properties of life as we know it can be explained by life's autopoietic organization. But what makes an organization autopoietic? The characterization of autopoietic organization goes as follows:

> An autopoietic machine is a machine organized (defined as a unity) as a network of processes of production (transformation and destruction) of components that produces the components which: (i) through their interactions and transformations continuously regenerate and realize the network of processes (relations) that produced them; and (ii) constitute it (the machine) as a concrete unity in the space in which they (the components) exist by specifying the topological domain of its realization as such a network. (MATURANA; VARELA, 1980, 78-9, italics removed)

The authors use 'autopoietic machine' to refer to the theoretical construct articulated by them, life as we know it is but one instantiating set of structures of this type of 'machine' (organization). I use the term "autopoietic system" instead, an autopoietic system is any system that displays an autopoietic organization. Following more recent enactive work (DI PAOLO 2018; THOMPSON 2022) I refer to condition (i) of the passage above as *self-production* and to condition (ii) as *self-distinction*. Self-production means that in the operation of the processes of the network the set of relations between the processes are themselves re-established (continuously regenerating). The self-distinction condition of autopoietic systems concerns the fact that the network emerges as a distinct unity apart from its surroundings (even if in constant changes in structure). Autopoietic systems materially self-produce and self-distinguish, they create themselves and separate themselves from everything else.

Thus conceptualized, autopoietic systems also have the property of being "organizationally closed" or "operationally closed". All the processes that make up the system are enabled by other processes of the system in a continuous circular manner. It follows that no process is freestanding or self-sufficient. Although organizationally closed, such a system is both materially and interactionally open to its environment. Some processes that do not belong to the unity can enable processes within the network, but they are *external* because they themselves continue to exist without the network. Sunlight enables photosynthesis, but the Sun exists independently of the plants. Following the seminal work of Francisco Varela (1979), operational closure is a general and distinct systemic-scale property that certain types of systems can have, autopoietic systems are but one subclass of the wider class of operationally closed organizations. Operational closure is also the technical definition of autonomy, what allows us to say that autopoietic systems are autonomous systems.

The exemplar of autopoietic organization found in the literature is the living cell. The cell is a complex unity observably distinct from the milieu in which it interacts. The cell's structure quite clearly exemplifies the dynamic self-production and self-distinction that autopoietic theory deems the basis of life. The model of autopoietic organization is formulated by close attention to cellular life, but it is independent of it, any system with interdependence between a self-distinguishing semipermeable boundary and reaction network that produces such boundary is an autopoietic system. Of course, the question whether a given concrete system instantiates an autopoietic organization sometimes can be a matter of debate. Kauffmann (2000) and Thompson (2007) disagree about the claim that autocatalytic sets of molecules can organize in an autopoietic way. Randy Beer (2015) offers a mathematical model of autopoietic organization, but the topic is not settled.

The case of the single cell is quite straightforward, some other concrete systems are more open to debate, but how does autopoiesis address multicellularity? Autopoiesis is not just a theory of the cell. Here we need to introduce the distinction between first and second-order autopoietic organizations (see chapter 4 of MATURANA; VARELA, 1987). In a nutshell, second-order autopoietic organizations are the aggregates formed by first-order autopoietic organizations. Living cells are conceptualized as first-order autopoietic systems following the criteria above. The multicellular aggregates formed by those first-order autopoietic systems can be called second-order autopoietic systems. The metacellular organization, as it is called, is defined as any unit that under close inspection reveals cell aggregates in close coupling with each other and the environment as its structure. Metacellular systems would therefore include multicellular organisms, but also organic tissue, organs, and for Maturana and Varela (1980; 1987), colonies and societies.

However, the challenge of characterizing metacellular systems as first-order autopoietic systems runs into some theoretical and empirical difficulties. The technical criteria of self-production and self-distinction demand more than self-organization and metastability. The molecular process of development of metazoans can help us make the case that metazoans are organisms that are both second-order and first-order autopoietic systems, even if it does not settle the question. Metazoans, for the most part, are the result of the operations of a single cell, the zygote, a brief but crucial stage of the metazoan life cycle. At the beginning we were a first-order autopoietic system. The question is if we maintain such an autopoietic organization in the process of cellular replication and type specification.

Independently of the status of some metacellulars as first-order autopoietic systems, one can claim that organisms are autonomous with the theory developed so far: autonomy (MATURANA; VARELA 1987, 89). Even if a metacellular is not a first-order autopoietic system, it can still be an autonomous system. Varela’s (1979) efforts in defining autonomy were sensible to the consideration that this property can be instantiated by a very diverse set of systems. Being autonomous, they would be systems that produce and regulate their own internal topology and functional boundary (the idea of operational closure). Therefore, in the case of metacellular organisms, their activity would be understood as the joint structural coupling of multiple individual first-order autopoietic systems that maintains the organization that characterizes that larger unity, for an example from plant behavior see (MATURA; VARELA 1987, 142-145).

At this point I can elucidate the notion that, according to classical autopoiesis, an autopoietic system is *necessarily* a cognitive system. The term "autopoiesis" would refer to the organization of the system, whereas the term "cognition" would refer to what the system does to remain an autopoietic organization in the structural coupling with the environment. What is cognition's biological function? Or, what does cognition do for an organism? It helps to maintain its identity through constant change. The organization of a system generates the interactive domain in which the system operates without losing such organization, the behavior (that is enable and constrained by the domain) is their cognitive performance: 'A cognitive system is a system whose organization defines a domain of interactions in which it can act with relevance to the maintenance of itself, and the process of cognition is the actual (inductive) acting or behaving in this domain.' (MATURANA; VARELA 1980, 13). Distinct and more specific organizations, such as the nervous system, would bring about the emergence of different domains of interaction where different forms of structural coupling would take place. Cognition in this perspective would then be the operations or behavior of a system in relation to the demands for the preservation of its identity imposed by a certain domain of interactions, where the domain is defined by the organization. Brains expand cognition significantly, but it is already present in the activity of prokaryotic bacteria (the simplest life form found in our planet).

Among the goals of classical autopoiesis was not only to give an organizational account of life's basic units, but also to give an account of it that does not rely on (apparently) suspicious notions like "purpose" and "aims": 'if living systems are physical autopoietic machines, teleonomy becomes only an artifice of their description which does not reveal any feature of their organization' (MATURANA; VARELA, 1980, 86). The difference between a hurricane and my cats, amongst other features, is in the organization of the parts, not in the presence or absence of motivations and goals. The project was to explain the characteristics of the living (cognition, reproduction, evolution, but also what we usually describe as motivation and goals) with only the help of some central notions like autopoietic organization and structural coupling (VILLALOBOS; PALACIOS, 2021).

3 Minimal life and purposiveness: the enactive approach

Classical autopoiesis is against the DNA-centric views of its time and against brain-centric views of cognition pervasive in cognitive sciences to this day, but does not try to reintroduce agency or goal-directness neither to the sciences of life nor to the sciences of the mind. The Enactive Approach on life builds upon classical autopoiesis. Autopoietic organization is a necessary condition for life, but not sufficient as originally proposed, something already questioned by those trying to advance the theory of autopoiesis (BITBOL; LUISI, 2005; BOURGINE; STEWART, 2004). Following a biogenic approach to the study of cognition, the fruitful path for the inquiry about cognition demands putting it in the context of how cognitive capacities contribute to the life of the organisms that have them. In this sense, EA is also one biogenic way of studying cognition.

The paths of EA and autopoietic theory diverge when it comes to the purposiveness of life. So how does enactive thinking naturalize purposes and what does that have to do with a characterization of minimal living systems? If one takes actual organisms as the model of the living one observes another crucial feature of life that turns out to be relevant for understanding the mind; Di Paolo (2018; 2005) calls it ‘adaptivity’. Adaptivity is a feature of the relation between a system and its own viability conditions. Systems have viability conditions, outside of those conditions, the system starts losing its integrity and in due time ceases to be. This applies to cyclones, as well as to a burning candle and living systems in general. If one puts a burning candle inside a glass, the candle stops burning due to the lack of oxygen. In this scenario one has moved the burning candle beyond its viability conditions. Now consider the scenario where the candle suddenly started trying to escape the glass, one in awe would be warranted to shout “It's alive!”. The candle would have in this scenario displayed adaptivity, the capacity to self-regulate with respect to the boundaries of its own viability. In more precise and operational terms, adaptivity is “a system’s capacity, in some circumstances, to regulate its states and its relation to the environment” (DI PAOLO 2005, 438).

Adaptivity involves several processes of attunement to the environment and reorganization of internal and external structure. Adaptive systems modulate their states in relation to their conditions of viability, which implies some form of self-monitoring of internal states in relation to the external states of its environment. It requires sensitivities related to and capacities to respond to breakdowns and to maintain itself in favorable situations, by moving away from the limits imposed by the viability conditions. The notion of autopoiesis does not allow gradation, as shown earlier, is an all-or-nothing affair. The notion of structural coupling, as defined in Maturana and Varela (1980), also doesn’t allow gradation and refers to conservation of organization, rather than improvement. Adaptivity, on the other hand, allows for degrees while it is also a whole system’s property not reduced to its parts. Adaptive systems behave as such by moving away from disadvantageous situations in favor of more advantageous ones.

Autopoiesis plus adaptivity allows us to expand our understanding of behavior and to naturalize purposiveness. First, it becomes necessary to adhere to a broader conception of behavior, in line with what is required from a biogenic approach. A working definition of behavior that seems to do the job has already been proposed by biogenic theorists. Behavior as ‘An organism’s capacity to adapt to changes in its internal or external milieux by changing its own structure and function (internal) and/or its spatial and interactive relations (external).’ (LYON et al. 2021, 5). The phrase “adaptive behavior” becomes redundant in the sense that all behavior aims at an adaptive self-regulation of the organism-environment system. But not all actual behaviors achieve their aim, and they vary between themselves in degrees of accuracy, effectiveness, energy consumption and so on.

In introducing the notions of adaptivity and behavior together, through the backdoor I introduced the notion of goal-directness. That was done implicitly in referring to a self-regulation according to a tendency to keep itself within boundaries set by viability conditions. That would be the general description of the goal of living. The organism itself is its goal. What one sees captured by those notions are aspects of the living that the notion of structural coupling was trying to capture without explicit reference or use of goal-directedness; those aspects are the changes in organism and environment brought forward by the organism’s active maintenance of its organization. For classical autopoiesis the goal (maintaining autopoietic organization) is in the eye of the beholder. For EA, one has good reason to ascribe the goal (keeping adaptive autonomy) to the systems themselves. Those two perspectives go along with the major trends in biological thinking mentioned in the first section. In the first case, reference to a goal is a heuristic tool. In the second, it is the change in point of view that allows for better characterizations of an organism's behavior. Adding the proper goal of self-regulation within boundaries set by viability conditions (adaptability) to the picture has ramifications. The purposiveness of life thus understood does not imply a final stage or ideal state of the organism. The set of viability conditions forms a ‘viability space’, there would be several regions that are neutral in relation to each other, that is, the organism would be equally adapted regardless of the comparatively neutral region it inhabits. Norms are derived from the goal of adaptively maintaining autopoiesis, the conditions in which the organism presently finds itself are differentiated as neutral, better or worse. There is an inherent normativity that follows the naturalization of purposiveness, but such normativity is somewhat open-ended since the normative framework can change over time, both at the scale of individual ontogeny and in transgenerational timescales.

Organisms constituted of autopoietic units (multicellular beings) display the general feature relevant for enactive theorizing; they are instances of *adaptive operational closure under precarious* *conditions*. Precariousness is a complement to Varela's (1979) account of autonomy that helps explain the *active* self-regulation in relation to the environmental conditions. The basic idea is that precarious autonomous systems not only maintain themselves, they enable themselves as well, they produce the preconditions for their own existence. The proposal was made of defining an autonomous system as 'a system composed of several processes that actively generate and sustain an identity under precarious circumstances.' (DI PAOLO 2009, 15). The reasoning is that proper, non-trivial autonomy, requires precariousness. According to the enactive approach, the equation that best encapsulates minimal life is "Life = autonomy plus adaptivity", but autonomy here follows the formula "autonomy = operational closure plus precariousness". Organisms have the capacity to adaptively regulate their operations and their relation to the environment depending on the virtual consequences for their own viability and flourishing. Their operations can be described as proper acts and behavior, such descriptions are not shorthand or useful heuristics. Rather, they are supposed to be the reinstating of an agential vocabulary in a disciplined mode of inquiry about living organisms in conversation with current sciences. The consequence of the enactive account of life is that with minimal individual life comes normativity, cognition and agency.

4 Cognition as sense-making

All the considerations of sections 2 and 3 above were about life, what about mind? If life implies goal-directness is not hard to see how it would require mindedness. Organisms understood in terms of natural purposes with vital norms that are enacted by the organisms themselves entails some form of regulating themselves in relation to those norms. Tracking current states (internal and external), capacities for anticipation of possible future states and compensatory capacities for avoiding the complete loss of identity, would be operations of such systems. It is because of the purposiveness of the organism that the surroundings of such a system show up as a web of significance between engagements that are beneficial and ones that increase tendencies of breakdown of its organization. Some interactions lead to better situations in regards to its autonomy, other interactions lead to worse situations, and organisms sense and respond to that in different degrees of efficacy and with different capabilities.

The notion of sense-making is the closest thing to a "mark of the mental" in EA. Similar to the relation between the terms "autopoiesis" and "cognition" in the classical autopoiesis literature, adaptive autonomy refers to the dynamic organization, while sense-making to the enabling activity. However, sense-making then refers to the on-going activity of keeping its identity through transitions. In an organismic register, that amounts to navigating the complexities of remaining alive and fulfilling metabolic needs while operationally closed throughout the life cycle. Differential responsiveness to events on the basis of those events having positive or negative values for the organism is another way of characterizing the sense-making of cognitive systems (THOMPSON 2022).

The canonical example of sense-making is a bacteria swimming uphill in a food gradient of sugar (THOMPSON 2007, 74–75, 157–58). In the case of the bacteria swimming uphill in a gradient of increasing concentrations of sugar, sugar is a chemical compound in the surroundings, but ‘food’ as a content in the broader sense used in the Introduction (a mode of presentation of that chemical compound) is given only by the activity of the bacteria as an autonomous system:

> significance and valence of sugar are not intrinsic to the sugar molecules; they are relational features, tied to the bacteria as autonomous unities. Sugar has significance as food, but only in the milieu that the organism itself enacts through its autonomous dynamics. (THOMPSON; STAPLETON, 2009, 25)

It is because of the value that sugar has for the bacteria as something it needs for its material turnover that sugar in that interaction presents itself as “food”. The endogenous activity of the organism is part of the constraints on how things appear as they appear. More generally, it is because organisms have needs related to their self-maintenance that they value things in a “web of significance”. The contents or modes of presentation of a cognitive system are always going to be related to the endogenous activities of the organism. Sense-making is not the active (and intellectual) structuring of sense experience or representations; it is a corporal activity of discrimination of environmental structures in terms of salience.

What a researcher sees when studying populations of *E. coli* in a microscope is how they react differently to different chemical gradients. Attempts to explain such occurrences can restrict themselves to the molecular scale and the properties of the different chemical compounds and receptors in the single cell organisms. However, according to EA, generating new and responding to already existing viability conditions (values) is part of a more complete explanation of such happenings. Basal cognition is not the process of representing independent states of affairs. Rather, cognition is the process of generating relevance for the system through the need of maintaining an identity at the always present possibility of disintegration (THOMPSON 2022).

Differently from the notion of structural coupling, sense-making is explicitly an asymmetrical relation, the direction of the relation is given by needs of the autonomous system under appreciation.A skeptic can say that cognition as sense-making is not a good definition of cognition, since it leaves out other supposed features of the phenomenon or includes features not related to it. Even if sense-making is only proto-cognitive or quasi-cognitive, due to its ties to minimal life, any biological or biogenic account of cognition would have to include what is being captured by the notion of sense-making. Cognition is a normative notion and sense-making appropriately naturalizes norms as the viability conditions to which a system is responsive to. Of course, as correctly brought to my attention by an anonymous reviewer, the naturalization of normativity as responsiveness to viability conditions most likely will prove itself insufficient to give a complete account for all the normativity found in the diverse cognitive performance of organisms, other concepts are needed. In this regard, to account for perception, for instance, EA brings forward supplementary notions like their anti-representational understandings of mastering sensorimotor contingencies and of Piaget's framework of assimilation and accommodation towards equilibrium (DI PAOLO*et al.,* 2017). To build upon the notions explored in this paper is the task of anyone aiming to develop the naturalization of the mind proposed by the enactive approach. I'm highlighting in this paper the major insights of the cornerstone of this project, the deep continuity between life and mind.

5 Proposing an operational definition of agency

Something has been assumed in this whole discussion so far and needs to be better characterized: the notion of agency being implicitly assumed. The notion is assumed both in the working definition of cognition and in the working definition of behavior. The agent is the one behaving and doing the cognizing. Behavior and action are typically associated in philosophy with concepts such as volition, desire, intention, motivating reasons and reasons to act. Recently, enactive cognitive science and theoretical biology have associated behavior with agency rather than with intentionality or the related concepts of the previous sentence due to some connotations of those terms. Agency as in the capacity to act is contrasted to systems that are only subjected to forces and constraints, as in being acted upon. Di Paolo et al (2017: 109–10) compare a sheep, a lamb and a group of small rocks going downhill on a slippery mountain. All of them are subjected to the laws of physics, but we can observe clear differences between the descending or falling of each one. Intuitively, the small rocks are not agents and it is possible to distinguish between different levels of agency in the lamb and sheep.

But to assume an intuitive notion of agency without effort to more precisely delineate it is a mistake. The problem is at least twofold. First, relying on an intuitive notion without proper characterization is unproductively polysemic. What counts as an agent becomes a matter of seeing-as, it would rely on preconceived notions not universally shared. For some, agency includes only humans. For others, humans and some animals. Some would associate agency more directly with complex motility, so it would include both bacteria and us, but would leave out plants and perhaps include particular kinds of robots. Another matter with this seeing-as is the associations between agency and other concepts, such as goal-directness and experience. Some might judge goal-directness as sufficient for agency, others might associate agency with sentience and the experiential aspect of living; if something is an agent, there is something that it is like to be them? An intuitive notion is too vague. The second problem is that, like goal-directness and purpose, agency does not look at first glance compatible with the natural sciences.

Typically, natural events are conceptualized in stark contrast with actions, which creates a challenge for a unified scientific picture of both. Agency has the same problem as purposiveness, certain events involving biological individuals seem to require it for their explanation, but it is unclear if the use of the concept is just a useful heuristic or should have a more putative status. As with purpose, EA aims at reinstituting 'agency' as a serious scientific category. The proposal offers three necessary jointly sufficient conditions for agency: *individuality, normativity and asymmetry* (BARANDIARAN *et al*., 2009; DI PAOLO *et al.* 2017, Chapter 5). The three criteria are interwoven in a way that the elucidation of one makes apparent the necessity of the other two.

Normativity is the more easily graspable condition. Proper actions require reference to conditions to which an interaction is responsive and sensitive to when being carried out. While playing volleyball one cannot hold the ball because it is easier than the single contact demanded by the rules. Without such a normative set of conditions, it is hard to describe an action as that particular action."Action" is a category that has normativity built into it. Going back to the case of chemotaxis, the description of the behavior as a *proper behavior* (and not just a physical-chemical occurrence) required the additional claim that the movement towards attractors and away from repellents is in response to a value-laden environment. Another example is given by Barandiaran *et al*., (2009), they contrast proper action with the spams of a person suffering from Parkinson's disease. There is an event with a causal explanation, but there is no non-derived sense in which it makes sense to classify the spasms as successes or failures, there is no dimension of normative evaluation from the agent's point of view. Another important distinction concerning normativity is the one between norm-following and norm-establishing. Extrinsically teleological systems are normative only in the sense of being law-abiding relative to a perspective. Normative frameworks from an observer perspective can be applied to such systems. One example is a clock, an artifact that can be judged on its accuracy. Extrinsically teleological entities are only norm-following entities, it can be said of them that they follow norms of a given framework. Maturana (1987) assumes that all assessments of adequate conduct are relative to an observer, which implies that all the normativity that can be studied is of the norm-following variety. Normativity is only in the eye of the beholder.

A more robust account of agency, where agency is not just in the eye of the beholder, demands an account of intrinsic teleology, for agents to be agents they need to be normative in a strong sense, as being both norm-following and norm-establishing. To argue that a system displays normativity in the stronger sense of the term one has to argue that the system is a certain type of individual where goals are not derived from something or someone external to it., Therefore, normativity and individuation are especially connected. I already argued that biological individuals (organisms) are intrinsically teleological. A corollary of this characterization is that *to do* (as in to pursue goals) is both the consequence and the condition of possibility of an organism's existence. The individuation of teleological systems (what they are) is co-defined with some of its processes (what they do). For EA ‘agents are systems that *actively define themselves as individuals*, and may be identified as such without arbitrariness’ (DI PAOLO*et al* 2017, 112). It is because of this constant individuation that autonomous precarious systems can be identified as individuals, clear criteria for predicting that X is an agent is provided; it is not just a matter of intuitively seeing-as anymore. Cellular life fits the criteria, but the proposal is that any system with such active ongoing individuation also would have normative relations to its environment. In other words, we could discover agents when investigating complex systems. In fact, EA claims that agency is also found in the sensorimotor and social scales.

The last of the three criteria is interactional asymmetry. Agents act on their environment, not the other way around. The language of actively undergoing constant individuation used above already points to the asymmetrical relations of agents with their environment. The agent is the source as well as the result of their individuation. Causation in complex systems is a very complicated topic to tackle, let’s consider interactional asymmetry as the modulation of the encounter with the environment whose source is the agent; agents as causes of certain events. Interactional asymmetry relates to the ways agents direct their path in the coupling with their surroundings. That can happen in a variety of ways. EA highlights two general senses in each the agent modulates the encounter, as controlling the flow of energy in interaction and a statistically causal sense (DI PAOLO*et al.*, 2017; BARANDIARAN *et al.,* 2009). First, one way of modulation is by control of energy flows. Agents manage and gather the energy resources for action. Pumping ions through the ion channels in the cellular architecture and chemotaxis directed by metabolic needs are ways systems constrain the flow of energy to sustain processes that move the system away from the general tendency of thermodynamic systems, thermodynamic equilibrium. That is very different from a candle burning its wax as fuel as long as the situation allows it, and it is also very different from being moved by a strong wind or river flow. In this sense, a system that controls the flow of matter and energy between itself and the surroundings, while staying in the same relative position in space, displays interactional asymmetry.

The chemotaxis example is one in which a negative tendency is avoided, but not all forms of modulating the interaction with the environment are negating negative external tendencies with some internal mechanism or complex behavior. Exploiting positive flows of matter and energy is as important as negating disturbing tendencies. Our own bipedal upright walking can be described as a “controlled falling” where we exploit gravity for locomotion (DESILVA 2021). Agents can be understood as the source of their actions in the sense of being what drives the energy resources (of an otherwise neutral interaction) in the direction of some of the system’s goals (what connects interactional asymmetry with normativity and individuation). Driving or directing energy resources can have an element of passivity in the sense that the agent might let themselves be carried by a favorable external energy flow that does most of the enactment, as in birds gliding or a person surfing. The second way in which we can understand the agent’s modulation of their encounter with the environment is by trying to assess statistically how one system (the agent) affects another system (the environment). Interactional asymmetry would be the case when changes in the system identified as the agent precedes in time changes in the system identified as the environment in a statistically significant way. Regardless, what marks the agent as the agent in this interaction is the capacity of altering the conditions of the agent-environment interactions in some situations.

The “some situations” condition is important because it highlights the contextual aspect of action. Di Paolo *et al.,* (2017: 118) give the example of a cliff diver. The driver standing at the edge of a cliff does a series of muscle movements that result in a dramatic change in the constraints of the interaction with their surroundings. The movements put the agent in a situation of free-fall, hopefully in the direction of a deep enough body of water. But had the diver not positioned himself on the edge of the cliff, the same neuromuscular changes would not result in a change in the situation, from standing to free-fall. Actions are contextual, which means they are spatio-temporally extended and dependent on their proper environments. The environment can also be a source of asymmetric modulation, such as falling off a cliff due to a strong wind. It is not asymmetry alone that defines an agent, rather the joint conditions of self-individuation, normativity and interactional asymmetry. As defined, *agency is the self-modulation (or self-regulation) of the autonomous organization's interactions with the environment according to an intrinsic normative framework.* In the most general sense, an action is an instance of agency as characterized in the sentence above. To act a system must be of the purposive kind, that is what guarantees that the system is not only norm-following (a notion relative to an observer perspective), but also norm-establishing (capable of generating and following their own intrinsic norms). It is the three conditions together that allow talk of agency instead of the classical autopoiesis notion of structural coupling, for instance. Agency will henceforward be taken to be a systemic-scale propriety instantiated at different scales, biological individuals being just one example.

6 Final remarks: from a philosophy of biology to a philosophy of mind and back again

I have argued that living is a teleology-constituted mode of being, that all living systems are cognitive and agential in a basal sense. Living systems' activity is constituted by path-dependent, context-sensitive goals, the more basic goal being maintaining its precarious autonomous self-organization under constant material and energetic influx. The goals, the context and the path emerge in the actual operation of the system, they are *enacted*. Purpose, normativity and meaning are not out there in ready-made form. The relation to the environment where meaning arises, the relation that creates and enables normativity and purpose, was labeled cognition. In the broader sense in which mind and cognition are synonyms, mind and life are coextensive, yet distinct. More broadly, the mind is understood as the complexification and enrichment of the organizational properties distinctive of life. To show how the claim is not preposterous, I started this with the problem of the place of purposiveness and teleology in the life sciences. The problem was already a topic of discussion in the 18th century and one can reconstruct a Kantian legacy of two competing approaches to the problem in contemporaneous theorizing about life, the heuristic stance and the naturalizing project. One of the approaches, the minority position favoring naturalization, sees Kant's thought as a launchpad for a radical understanding of biological systems that reinstates teleology as a legitimate concept in the study of nature. EA goes in this direction, building upon the theory of autopoiesis. I have shown the enactive naturalization of purposiveness, in which purpose and meaning are directly tied to the fact that living beings are self-producing, self-distinguishing adaptive systems keeping their existence under precarious conditions. Meaning and purpose come from the active self-regulation that enables our precarious existence.

The account of mind provided is in direct dialogue with a solution to a problem of the philosophy of the life sciences. For this reason, I presented to you a journey from philosophy of biology to philosophy of mind. In a sense, a way of naturalizing philosophy of mind. As is the case with any theoretical proposal, some intuitions and metaphors guide the development of its operational definitions. The account of mind provided aims to put the mind in the context of living, it is a biogenic approach. The model of cognitive performance most explored was metabolic driven chemotaxis, phenomena of interest to microbiologists. But going from life to mind does not mean that the account reduces the mind to biological phenomena. The identity that self-produces under precarious circumstances coupled with their domain of interactions forms an extended developmental system that transforms itself over time, going from one dynamically stable configuration to the next. It is outside of the scope of this paper, but if one looks at the sensorimotor development of individuals, a similar organization is found at the scales of habitual behavior of animals (DI PAOLO*et al*., 2017). If one zooms out to social interaction and language, a similar organization also occurs at the scale of social acts (DI PAOLO*et al*., 2018). Nature and culture are in a continuum, they are intertwined processes and products of each other. This is the core of the deep continuity between life and mind. Not the reduction of mind to life, but the opening up of life to the flexibility, historicity and path-dependency that we unproblematically attribute to mind and culture.

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Recebido em: 01/08/2025

Aceito em: 08/09/2025