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# Ontological Emergence: How is That Possible? Towards a New Relational Ontology

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**Abstract** In this article I address the issue of the ontological conditions of possibility for a naturalistic notion of emergence, trying to determine its fundamental differences from the atomist, vitalist, preformationist and potentialist alternatives. I will argue that a naturalistic notion of ontological emergence can only succeed if we explicitly refuse the atomistic fundamental ontological postulate that asserts that every entity is endowed with a set of absolutely intrinsic properties, being qualitatively immutable through its extrinsic relations. Furthermore, it will be shown that, ironically enough, this metaphysical assumption is implicitly shared by all the above mentioned alternatives to Emergentism. The current article concludes that the notion of organization by itself is not enough, and that ontological emergence can only be justified by assuming a *relational* ontological perspective that, in opposition both to atomism and holism, defends that the existence-conditions, the identity and the causal behavior of any emergent systemic property can only be conceived, and explained, as constructed by and through specific networks of *qualitatively transformative* relational processes that occur between the system's components and between the system and its environment. Additionally, I try to explain how one can make sense of the idea that an emergent phenomenon is both dependent on, and autonomous from, its emergence base.

**Keywords** Emergence · Relational ontology · Atomism · Holism · Micro-reductionism · Qualitative change

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## 1 Introduction

Emergence is a generation process whereby a produced phenomenon (the ‘emergent’) is not completely reducible to the set of previous phenomena from which it was generated (the ‘emergence base’), in the sense that it represents a *qualitative novelty* and manifests some degree of *reality* or *autonomy* over and above the set of its base elements. That is, although an emergent phenomenon comes into existence as a result of some set of previous elements in relation, an emergent is never a mere derivative epiphenomenon of a production process, having its own ontological status, identity and causal efficacy.

Ontological emergence can be conceptualized as occurring in the transition between different levels of composition and organization (parts–wholes relationships), or in the transition between different temporal stages of development. Therefore, an emergent phenomenon can be conceived as a global effect in relation to its several partial causes, as a compound system in relation to its constituent parts, as a property in relation to lower-level properties, or as a stage of a process in relation to previous stages.

Let us here conceive ontological emergence in the traditional way, that is, as the claim that if a given system is conceivable as an ontological emergent entity, then it must have some new types of properties, behaviors and laws that are somehow autonomous from, and irreducible to, the sum of the individual properties, behaviors and laws of its parts.

That is why the in-principle impossibility of providing an explanatory micro-reduction, as defended by *part–whole microphysicalism*, can be taken as the hallmark of ontological emergence (Hüttemann 2004: 32–39, 2005: 115). This kind of micro-explanation concerns the lawful behavior of a compound system in terms of its constituent parts: the laws that pertain to compound systems must be explained in terms of the laws of its constituents. In this sense, a systemic property is non-emergent iff it can be fully explainable in terms of

- (i) an exhaustive knowledge of the intrinsic (monadic) properties of the lower-level components, in addition to
- (ii) the lower-level laws that obtain over those intrinsic properties (laws concerning the behavior of the component parts considered by themselves, and thus considered in a ideal isolation); and to
- (iii) some laws of composition and quantitative interactions—that is, laws that have as their relata the intrinsic properties of the component parts, accounting for their quantitative co-variation, and expressing how the behaviors of the separate parts are compounded when they act together in some proportion and arrangement (Hüttemann 2004: 35; Hüttemann and Papineau 2005; Garson 2006: 230).<sup>1</sup>

Emergentism can thus be taken as an opposite perspective to part/whole micro-reductionism. The problem is whether this anti-microreductionism is ontologically motivated, or not.

My analysis will be here devoted to the ontological conditions of possibility for emergence.

<sup>1</sup> When Hüttemann includes “general laws of interaction” as necessary ingredients of a micro-reduction he has in mind what C. D. Broad called ‘laws of composition’. These laws contain two kinds of information: “an information on how systems or components combine if there are no interactions present, and on the other hand, information on the effects these interactions will have on the combined systems” (Hüttemann 2004: 34). In this context, interactions can be equated in terms of modes of composition because when Hüttemann invokes Broad’s reference to interactions, he refers to a passage where Broad is considering only the interactions that are accounted by the framework of the ‘Ideal Pure Mechanism’ (Broad 1925: 44–45), according to which all the admissible interactions are the ones that merely change quantitatively the previously existing intrinsic properties of the relata, such as position, velocity or acceleration.

## 2 Emergence and Its Ontological Alternatives

There are two basic features that define some phenomena as emergent: they are *new*, in the sense that they don't exist at lower levels of organization, or in previous temporal stages of development, and they are *real*, in the sense that they are not mere epiphenomena, having their own ontological status and causal efficacy.

Given these two characteristics, there are only *four logical possible ways* of conceiving the putative emergent phenomena—four ways, indeed, that have been advocated in the history of philosophy and science until today.

1. Eleatism. The first possibility is the Eleatic one: to deny, right from the start, the two features that characterize emergent phenomena. They are *neither real nor new*. Being is One and undividable, all plurality and change being illusory. In this block Universe, a picture in which everything is given at the outset, there is no change, and therefore there is no generation whatever.<sup>2</sup>

2. Eleatic Pluralisms. The second possibility comes from the post-Eleatic pluralists (Empedocles, Anaxagoras, and the Atomists), according to which at the bottom level of reality there are indivisible, eternal and qualitatively immutable fundamental entities (the *stoicheia*), with everything else being epiphenomena directly derivable from the combinatorial relations and local movements of those building blocks, and of the mere quantitative variations of their intrinsic properties.<sup>3</sup>

The qualitative identity of any entity is thus taken to be previous to, and unchangeable by, any of its extrinsic relations. No atom or compound system can acquire new properties through its extrinsic relations, nor its intrinsic properties can disappear or be replaced by others. An entity can only change quantitatively, that is, the only kind of change allowed is the quantitative variation of its intrinsic properties, in terms of their magnitudes and proportions.<sup>4</sup> Therefore, the putative emergent phenomena are *new, but not really real*, since what we take to be new properties are just the epiphenomenal outcome of a set of quantitative variations of previously existing properties.

The mechanistic paradigm of modern physics is the direct expression of this metaphysical view. As David Bohm observed,

the most essential and characteristic feature of mechanism (...) [is] to reduce everything in the whole universe completely and perfectly to purely quantitative changes in a few basic kinds of entities (...), which themselves never change qualitatively". [Indeed,] "[a]t bottom, the only changes that are regarded as possible within this scheme are quantitative changes in the parameters or functions (...), while fundamental qualitative changes in the modes of being of the basic entities and in the forms in which the

<sup>2</sup> As William Guthrie has said, "reality [is], and must be, a unity in the strictest sense and (...) any change in it [is] impossible" (Guthrie 1965: 4–5).

<sup>3</sup> In order to meet the Parmenidean metaphysics, "Anaxagoras, Empedocles, and the Atomists saw in [their] use of mixture and separation a mechanism for explaining the features of the phenomenal world without destroying or otherwise changing the basic entities of their theories" (Curd 2002: 142). The epiphenomenal nature of the non-fundamental entities and properties is taken so seriously that they could not even be said to come-to-be and to pass away. The apparent alteration, generation or corruption of some composed system is nothing but the association and dissociation of its ultimate immutable component parts or the change in their mode of combinatorial arrangements. See Vernant (1985: 373–402), and Kirk and Raven (1964: 405).

<sup>4</sup> By intrinsic properties, I mean the properties that an entity has of itself, despite its relations with other entities in its environment—that is, the possession of those properties depends entirely upon what an entity is like in itself—and *relational* properties are properties that an entity has and acquires solely due to its extrinsic relations with other entities. See Lewis (1983) and Francescotti (1999).

basic laws are to be expressed are not regarded as possible. Thus, the essence of the mechanistic position lies in its assumption of fixed basic qualities, which means that the laws themselves will finally reduce to purely quantitative relationships. (Bohm 1984 [1957]: 47 and 131).

3. Preformationism. The third option is to adopt a perspective that I shall call preformationism, and it includes the old hylozoism, the more recent forms of animism and panpsychism, and yet another perspective that I shall call potentialism.

Despite all their differences they all amount to the same way of thinking: the putative emergent phenomena are *real, but not really new*. That is, what seems to us an emergent qualitative novelty is just a different (higher) degree of quantitative intensity (of complexity, of perfection) of a quality already existing at previous levels, and in the last instance already performed at the level of the most basic and fundamental reality. For example, one may say that matter at the physical level is already, in some sense, alive and it manifests some psychic or conscious properties, just in some rudimentary ways. So, life and psychic properties are real and exist as such, but they are not new, since they are already manifested at the most basic level of physical reality.

Obviously, this perspective can be defended in more or less extreme ways, the overall strategy being the same. It is not the case that someone defends that quantum entities are able to perform self-replication. Likewise, it is not easy to find someone defending nowadays that quantum entities already manifest and perform some metabolic, intentional, or self-consciousness capacities. But the strategy is always the same: in face of what seems novel to us at some specific level of organization, there is always a tendency to look for it existing already at some previous levels. Thus, instead of new qualities, we have new degrees of intensity of previously existing qualities. Strawson's (2006) approach of panpsychism is such an example nowadays.<sup>5</sup>

In short, according to the preformationist view, qualitative change and development are nothing but the unfolding of what is already present since the beginning. The so-called central dogma of molecular biology—the genetic determinism (Robert 2004: 34–55)—and the Gesell maturational theory are good examples of this perspective.

The distinctive character of what I call potentialism lies in the assertion that the putative emergent phenomena are new but only in terms of their actuality. That is, the putative emergent phenomena already exist at previous levels of organization, only not in their *actuality*. Sydney Shoemaker is a well-known advocate of this position: emergent properties are just actualizations of properties already existing in potentiality. Indeed, as Shoemaker affirms, “[e]mergence requires that the ultimate physical micro-entities have «micro-latent» causal powers, which manifest themselves only when the entities are combined in ways that are «emergence-engendering» ” (Shoemaker 2002).

4. The fourth option is to answer positively to both characteristics: emergent phenomena are really new, and they have their own ontological status. Still, this answer can be made by two completely opposite frameworks:

#### 4.1. Super-naturalist Substance Pluralisms.

On the one side, there is the super-naturalistic vitalism and other substance pluralisms, according to which the different qualitative levels of organization (physical matter, life, mind, etc.) are made up of different and autonomous levels of substances not completely integrated and causal related to each other.

<sup>5</sup> For a Whiteheadian defense of panpsychism, in terms of a ‘pan-experientialist physicalism’, see Griffin (1998).

**Table 1** Four logical ways of conceiving putative emergent phenomena

New	Real	Doctrines
0	0	Eleatism ( <i>aka</i> block universe)
1	0	Eleatic pluralism ( <i>aka</i> atomism) <sup>a</sup>
0	1	Preformationism and potentialism
1	1	Substance pluralism versus emergentism

<sup>a</sup> Although Empedocles, Anaxagoras and the Atomists are all part of the same philosophical post-Eleatic movement, Atomistic doctrines became more influential in the history of philosophy and science. That is why atomism can be used today as an umbrella term for that movement, at least regarding the defense that no entity (simple or compound) can undergo a qualitative or a substantial kind of change through its extrinsic relations, and the defense that any relational or compositional process is a mere combinatorial association between qualitatively immutable entities (Wardy 1988; Graham 1999)

#### 4.2. Emergentism.

On the other side, there is emergentism, a perspective that always tried to avoid both classical mechanism and vitalism, looking for a naturalistic explanation for the emergence, in terms of some relational processes among lower level entities.

In opposition to emergentism, substance pluralisms state that the qualitative novelties are not completely causally connected or articulated with the lower-levels of organization, since the qualitative behavior of a living organism, for example, is also dependent on some peculiar force or component that exerts “some kind of directive influence over matter which enters the organism from outside” (Broad 1925: 56). On that account, qualitative novelties are ultimately generated by some supernatural or extra-physical principles or forces: souls (e.g., Thomas Aquinas, Descartes), *entelecheia* (Hans Driesch), *élan vital* (Henri Bergson), *Intelligent Design*, etc.

We get this Table 1 with the four possible answers to the two characteristics ascribed to emergent phenomena: their qualitative novelty, and their own ontological status:

### 3 The Ontological Issue: Dilemmas and Impasses

If emergentism differs from any substance pluralism in trying to develop a naturalistic account of qualitative novelties, how does emergentism explain and justify their formation?

As it is well known, emergentism tried to present itself as an intermediate position between atomistic mechanism and vitalism. C. D. Broad states very clearly the fundamental problem: “Are the differences between merely physical, chemical, and vital behavior ultimate and irreducible or not?” (Broad 1925: 53). And in the context of his particular inquiry about the place of mind in nature, he says:

The question which is of the greatest importance for our purpose is the nature of living organisms, since the only minds that we know of are bound up with them. But the famous controversy between Mechanists and Vitalists, about living organisms is merely a particular case of the general question: Are the apparently different kinds of material objects irreducibly different? (Broad 1925: 43).

So, what kind of ontology can support the naturalistic emergence of qualitatively new phenomena? How is that ontologically possible?

It is my opinion that British emergentists of the late nineteenth century explicitly rejected the atomistic mechanism’s worldview, but they were unable to explicitly propose an alter-

native ontology. In fact, their ontological comments were usually limited to vague allusions to holism—the whole is different from the sum of its parts—to the coercive causal power exercised by certain wholes on the behavior of their parts, to ‘new kinds of relatedness’, to ‘relations or syntheses *sui generis*’, or to the existence of ‘non-additive relations’.

As it is well known, the original definition of emergence was based on a fundamental distinction—stated by Stuart Mill—between two different ways in which several agents or causes can act together to produce the same effect: “[the] difference between the case in which the joint effect of causes is the sum of their separate effects, and the case in which it is heterogeneous to them” (Mill 1868 [1843]: 405). So, an emergent phenomenon represents the case where a ‘heteropathic’ effect is not the sum of what would have been the effects of each cause acting alone or in other type of relational context. In such cases the ‘principle of composition of causes’ fails. That is, the principle of the proportionality of effects to their causes (the superposition principle) fails.

The focus on non-additive relations is understandable, since “[t]he essential feature of a mechanical—or, if it be preferred, a mechanistic—interpretation is that it is in terms of resultant effects only, calculable by algebraic summation. It ignores the something more that must be accepted as emergent.” (Morgan 1923: 8).<sup>6</sup> If emergent phenomena somehow involve, or are generated from, non-additive relations, they are not explainable or reducible through the traditional atomistic (additive) kind of approach. But the question of why and how do these non-additive relations arise was left without an answer. No ontological explanation was ever given for the occurrence of those types of relations.

Sure, all British emergentists were well aware of the epistemological consequences of the inadequacy of the traditional additive or linear approaches, and of the fundamental inapplicability of the classical superposition principles of atomistic mechanism as explanatory principles of phenomena involving non-additive relations—and that’s why they were labeled emergent, and considered to be non-explainable, non-reducible, non-deductible, and/or non-predictable.

But special kinds of relations, *sui generis* relations, or non-additive relations, are all expressions that indicate a problem, and they ultimately say nothing about the causes and the mechanisms able to engender those special types of relations, new qualities, new causal powers, or new behaviors, called emergent. So, why and how do these *sui generis* and non-additive relations arise? The emergentists were silent on this issue. The existence of emergent properties must be accepted with ‘natural piety’, as a brute empirical fact, admitting no explanation (see Alexander 1979 [1920]: 46–47; Morgan 1923: 8).

That is why emergentism was mostly a negative and skeptic perspective, something that helps to explain its bad reputation, at least until the 80s and the 90s of the twentieth century.<sup>7</sup> Emergentists were against both atomistic mechanism and vitalism, but they were unable to elaborate a positive epistemological approach, largely in virtue of the fact that they were unable to propose an alternative ontology.

<sup>6</sup> In the same vein, (see Broad 1925: 61).

<sup>7</sup> According to McLaughlin (1992), British emergentism lost its positive reputation with the (allegedly successful) quantum mechanical reduction of chemistry. However, emergentism and related themes made their reappearance between the World Wars, particularly in embryology, and through organicist approaches in developmental biology (Gilbert and Sarkar 2000), as well amongst some neuroscientists (like Roger Sperry), after the 1960s. Finally, according to Kim, the main reason why “emergentism failed to become a visible part of the Problematik of the mainstream philosophy of science”, is that “philosophy of science during much of the middle half of this century, from the 1930s to the ’60s—at least, in the analytic tradition—was shaped by the positivist and hyper-empiricist view of science that dominated the Anglo-American philosophy at the time.” (Kim 1999: 3–4).

### 3.1 Organization is Not Enough

The only tentative answer that British emergentists were able to give to the problem of the formation of emergence processes was given in terms of the production of new kinds of relations, forms, patterns or organizations. It was said that emergent systemic phenomena occur in virtue of the formation of different kinds of organizations between systems' components. As C. L. Morgan said,

[Emergence involves] a new kind of relatedness (...). If it be asked: What is it that you claim to be emergent? – the brief reply is: Some new kind of relation. Revert to the atom, the molecule, the thing (e.g. a crystal), the organism, the person. At each ascending step there is a new entity in virtue of some new kind of relation or set of relations. (Morgan 1923: 19 and 64).<sup>8</sup>

In this aspect, many contemporary emergentist approaches have followed the same path. In the overwhelming majority of cases, the current characterizations of emergence are still focusing on notions such as organizational dependence or context-dependency, defending that emergent phenomena result from specific kinds of relations or 'essential interactions'.<sup>9</sup>

As Sunny Auyang has said, "[c]rudely speaking, resultant characters are more closely tied to the *material* content of the constituents; they include aggregative quantities such as mass, energy, force, momentum, and quantities defined exclusively in terms of them. Emergent characters mostly belong to the *structural* aspect of systems and stem mainly from the organization of their constituents." (Auyang 1999: 175–176). Another characterization of emergence is given, in the same vein, by William Wimsatt: "emergence of a system property relative to the properties of the parts of that system indicates its dependence on their mode of organization." (Wimsatt 2006: 673).<sup>10</sup>

That is why emergence is usually conceived as the antithesis of aggregativity, atomistic and mereological frameworks. But this can hardly be sufficient. Sure, organization plays a role in any emergence process, but it is not enough to show that the existence and identity of some phenomenon depends on the organization (or on the relations) between some previous or lower-level elements, in order to prove the emergent nature of that phenomenon. Likewise, it is not enough to state that emergent phenomena arise from some new special kinds of relatedness, as it is not enough to state that they depend more on the form than on the matter, or less on the components or ingredients of some system than on their relations. Organizational or context dependency is a necessary but not a sufficient condition for ontological emergence.

We must be clear on this point. The organizational dependency of some system's property means that it is not the product of the mere sum of the system's parts, since it depends also on their specific mode of organization. But this does not collide with micro-reductionism. Atomism has always acknowledged the dependency of the existence and of the identity of

<sup>8</sup> [Emergence involves] a new quality (...) distinctive of the higher-complex. (...) To adopt the ancient distinction of form and matter, the kind of existence from which the new quality emerges is the 'matter' which assumes a certain complexity of configuration and to this pattern or universal corresponds to the new emergent quality. (Alexander 1979: 45 and 47).

<sup>9</sup> This is the fifth characteristic feature of emergent properties, according to Humphreys (1997a).

<sup>10</sup> Mario Bunge proposes the same type of definition of emergence: "[t]o say that *P* is an emergent property of systems of kind *K* is short for '*P* is a global [or collective or non-distributive] property of a system of kind *K*, none of whose components or precursors possesses *P*' (...), and "[e]very new level is constituted by combinations of lower-level things." (Bunge 2003: 14–15).



every non-primitive property or entity on the different modes of relations, arrangements or organizations among their atoms. That was precisely the strategy followed by Greek atomists, in order to accommodate the Eleatic postulate of the immutability of the Being with our experience of the changeable plurality of things that populate our world. According to the atomistic worldview, the qualitative novelty and plurality of our world is explained as a mere effect of the variety atoms' types and of the diverse ways they are combined or organized, like lego pieces in a lego construction.

Thus, invoking mere processes of relation or organization without further qualification is of no help, and as a matter of fact the constant use of these unqualified or atomistic notions of organization has created many unnecessary problems.

Let us take as an example the eighteenth century article 'Naître' of Diderot and D'Alembert's *Encyclopédie*:

Life cannot be the result of organization. Take three molecules A, B, C; if they are not alive in the combination A, B, C, then why should they begin to live in the combination B, C, A, or C, A, B? This is inconceivable. Life is not like movement, but something else: whatever is alive has movement, but whatever moves is not necessarily alive. (...) Life is an essential and primitive quality in any living organism, which cannot be acquired at some moment, nor cannot be lost. We must distinguish between inert and active life. They are comparable to a living force and a dead force. If one removes the obstacle, the dead force will become a living force, and the inert life will become an active life.<sup>11</sup>

As widely known, according to Diderot, there is a kind of inert or active living 'sensibilité' inside all matter as a universal property. As Diderot wrote in a letter to Duclos (*Lettre à M. Duclos «de Châlons-sur-Marne»*), in October of 1765, "according to me, sensibility is a universal property of matter—a property that is inert in the brute bodies, like motion in heavy bodies stopped by an obstacle, and that becomes active in the same bodies by being assimilated with a living animal substance".<sup>12</sup>

But there are two problems in Diderot's argumentation. First, Diderot failed to understand the idea that molecules are not supposed to become alive when they are combined in a certain way. It is the system the molecules compose, that is, the *cell* that acquires the properties of life, since molecules do not metabolize, nor do they have any self-reproductive capacity. Second, Diderot failed to see that the relational organization between molecules could be the cause of the generation of the characteristic features of the life of cells, because he equated the notion of organization as a mere mode of arrangement between immutable relata (B, C, A; C, A, B, etc.).

In point of fact, how would a mere juxtaposition of inorganic parts arranged or combined in certain manners, be able to originate life from non-living elements? Diderot's preformationism in its potentialist version seems, indeed, the only available option if one denies

<sup>11</sup> "La vie ne peut être le résultat de l'organisation; imaginez les trois molécules, A, B, C; si elles sont sans vie dans la combinaison A, B, C, pourquoi commenceraient-elles à vivre dans la combinaison B, C, A, ou C, A, B? Cela ne se conçoit pas. Il n'en est pas de la vie comme du mouvement; c'est autre chose: ce qui a vie a mouvement; mais ce qui se meut ne vit pas pour cela. (...) La vie est une qualité essentielle et primitive dans l'être vivant; il ne l'acquiert point; il ne la perd point. Il faut distinguer une vie inerte et une vie active. Elles sont entre elles comme la force vive et la force morte; ôtez l'obstacle et la force morte deviendra force vive; ôtez l'obstacle et la vie inerte deviendra vie active." (Diderot 1975: 47–48).

<sup>12</sup> "(...) selon moi, la sensibilité est une propriété universelle de la matière; propriété inerte dans les corps bruts, comme le mouvement dans les corps pesants arrêtés par un obstacle; propriété rendu active dans les mêmes corps par leur assimilation avec une substance animal vivante." (Diderot 1957: 141).

supernaturalism, only having at his disposal the atomistic notion of organization as a mere combinatorial relation.

Nevertheless, this problem is older. As early as between the second and third centuries, Claudius Galenus was also confronted with a similar kind of problem. In his *De Elementis Ex Hippocratis Sententia*, he wrote:

Consider the first elements. Even though these substrata are unable to perceive, a body capable of perceiving can at some point come into being, because they are able to act on each other and be affected in various ways in many successive alterations. For anything constituted out of many things will be the same sort of things the constituents happen to be, should they continue to be such throughout; it will not acquire any novel characteristic from outside, one that did not also belong to the constituents. But if the constituents were altered, transformed, and changed in manifold ways, something of a different type could belong to the composite that did not belong to its first elements. (...) Consequently, something heterogeneous cannot come from elements that do not change their qualities. But it is possible from ones that do. (...) Therefore, it is necessary that which is going to sense be constituted either (i) from first elements capable of sensation or (ii) from ones incapable of sensation, but naturally such as to change and alter.<sup>13</sup>

Here is the dilemma: if we want to accept the reality of sensitive capacity, either we assume the qualitative mutability of the first elements through their own interactions in order to explain the emergence of that new capacity, or we deny that possibility and then we have to defend some kind of preformationism, according to which sensitive capacity is not an emergent property, since it is *not really new*. Nowadays, this latter view is followed by Galen Strawson, and it comes to no surprise, since his panpsychist perspective is limited to an atomistic/combinatorial notion of organization, in the light of which systemic emergence is supposed to occur when parts are “combine[d] in certain ways” (Strawson 2006: 12).

As one last example, we can recall the British naturalist Alfred Russel Wallace and his critical perspective about Darwin’s exclusively continuist and gradualist approach on evolution:

There is no escape from this dilemma – either all matter is conscious, or consciousness is something distinct from matter, and in the latter case, its presence in material things is proof of the existence of conscious beings outside of, and independent of what we term matter (Wallace 1870: 365).

According to Wallace, Darwin’s stress on evolutionary continuity and quantitative change could only lead to panpsychism,<sup>14</sup> but Wallace, rejecting that option (1889: 476), chose the dualism of matter and mind, postulating supernatural forces.

Now, one could obviously try to interpret Darwin’s approach as Stephen Jay Gould did: “We need not fear Darwin’s correct conclusion that we differ from other animals only in degree. A sufficient difference in quantity translates to what we call difference in quality *ipso*

<sup>13</sup> Excerpt *cit in* Caston (1997: 355–357). Strangely enough, Kim (2006b: 189) also quotes this passage from Galenus, but unfortunately he misses the fundamental idea of Galen’s hypothesis of a *qualitative transformation* of the component parts as the causal mechanism that can explain the process of systemic emergence.

<sup>14</sup> In fact, Darwin attributed some “intelligence” to worms “in their manner of plugging up their burrows”, referring to their “mental powers” (Darwin 1882).

*facto*” (Gould 1999). But Wallace did not acknowledge this possibility (see Wallace 1870: 365).

#### 4 Different Answers, But One Same Ontological Assumption

Following from this, why do we feel tempted to adopt some preformationist or substance pluralist approach when we want to accept the reality and the causal efficacy of properties such as the ones manifested by what we call life and mind?

The reason lies in the fact that, ironically enough, both preformationism and substance pluralism share the same fundamental Eleatic postulate in its pluralist version: the defining qualities of any entity are completely given by a set of absolutely intrinsic (monadic) properties. Therefore, any relation that an entity entertains with other entities must be conceived as a mere combinatorial kind of arrangement, no entity being thus able to undergo qualitative changes through its extrinsic relations, but only quantitative changes in the properties that it already has.

New systemic properties are in this manner nothing more than epiphenomenal effects of some quantitative variations of the components’ intrinsic qualities and of their modes of combination.

The difference between preformationism, atomism and substance pluralism resides mostly in their different philosophical motivations. Atomists are confident of the possible reduction and assimilation—at least, in principle—of everything to the properties, processes and laws of the fundamental entities of physical reality. Vitalists and preformationists, on the other hand, are not epistemologically confident of that program of reduction, and at the same time they want to acknowledge the specific ontological status and causal powers of biological and mental properties. Still, since they tacitly assume an ontological atomistic conception of matter, according to which no entity is qualitatively changeable through its extrinsic relations, they can only leave us these options:

- (i) either we introduce the apparent novelties in the heart of the most elementary level of reality, physical reality being thus taken as already somehow alive and psychic—or at least having already biological and mental properties in potency—so we avoid the problem of explaining their subsequent occurrence;
- (ii) or those novelties can only be explained by introducing extra-material or supernatural principles, substances, or forces.

On the other hand, if the atomistic view of reality is preserved, complexity, by itself, does not make any ontological difference, since nothing ontologically significant can arise from the mere sheer number or from the variety of the entities and their relations. In such cases, complexity has relevant epistemological consequences raising numerous challenges, but it is devoid of any ontological significance (Santos 2013). As a matter of fact, this would only correspond to weak emergence, in Bedau’s sense.<sup>15</sup>

<sup>15</sup> According to Mark Bedau, “[w]eak emergence refers to the aggregate global behavior of certain systems. The system’s global behavior derives just from the operation of micro-level processes, but the micro-level interactions are interwoven in such a complicated network, that the global behavior has no simple explanation. (...) weak emergent phenomena are ontologically dependent on and reducible to micro phenomena; their existence consists of nothing more than the coordinated existence of certain micro phenomena (...) [The state of a macro-entity] consists simply in the aggregation of the states of all its component micro entities and their spatial relations.” (Bedau 2002: 11–12 and 14).

This being said, if we want to evaluate the possibility of ontological emergence, what must be at stake is the possibility to overcome the atomistic ontology.

## 5 A New Relational Ontology

Let us emphasize that any ontology according to which all entities, beginning by the most elementary building blocks of the world—whatever they are: particles or waves, tropes, substances, states of affairs, etc.—are taken to be self-sufficient kind of entities endowed with a set of absolutely intrinsic (monadic) defining properties that are qualitatively immutable through their extrinsic relations, is an example of an atomistic metaphysics. Consequently, all interactions are conceivable as mere combinatorial relations, spatial configurations, or modes of arrangements that generate the occurrence of new qualities, as collective properties of such arrangements or organizations, but leaving intact the qualitative identities of their relata.

Being so, and if what I have been arguing is correct, the only option left to allow ontological emergence by naturalistic means, is to refuse the fundamental metaphysical tenet of Eleatic pluralism, explicitly assuming a relational ontology according to which the existence-conditions, the identity and the causal behavior of any entity must always be conceived and explained as *constructed* and *transformed* by the interplay of its intrinsic and extrinsic relational processes.

This relational view of reality does not merely mean that all things exist in a world of relations and are somehow interrelated to each other, but that their very existence, identity and behavior are constructed and transformed by specific systems of interactions.

I thus advocate a relational ontology in analogous terms of the ‘constructivist interactionism’ proposed by Oyama (2000) in the study of biological and cognitive development and evolution, according to the new developmental systems approach.<sup>16</sup>

In the light of such a *relational process* approach, reality is conceived as a continuously changing web of co-dependent relational construction processes between an ever indeterminate number of relations and relata, always transforming each other and co-evolving through different relational systems. (I say indeterminate in an epistemological sense, since we will never be able to determine with absolute certainty the ultimate level of composition of physical reality, nor the effective existence of such fundamental level).

In a truly relational ontological perspective, the basic categories are not relations (or structures of relations) and objects, but relations and relata. Objects are just one kind of entities (among others) that are able to assume the role of being a relatum. Therefore, it makes no sense to defend the ontological priority of one of the categories over the other. The ontological categories of relatum and relation form a dialectical unit, mutually presupposing,

<sup>16</sup> Lewontin (1983), Oyama (2000) and Gray (1992) use the notions of ‘construction’ and ‘constructivism’ to characterize their own perspectives regarding biological development and evolution, according to the new developmental systems theory. As Lewontin says in the ‘Foreword’ to the second edition of Oyama’s book, ‘constructivist interactionism’ is the view that “in the production of an organism one cannot regard the internal and the external, genes and environment, as alternative causes”, denying “the claim of the ontologically independent status of the causes as causes, aside from their interaction in the effects produced”; indeed, “they become causes only at their nexus, and they cannot exist as causes except in their simultaneous action” (Oyama 2000: xiv–xv). According to the constructionist, developmental systems perspective, traits are not transmitted to offspring, but are instead made or reconstructed in development. Likewise, evolution is not a matter of organisms or populations being molded by their environments, but of organism-environment systems reciprocally changing over time. Therefore, “the life cycle of an organism is developmentally constructed, not programmed or preformed. It comes into being through interactions between the organism and its surroundings as well as interactions within the organism.” (Oyama et al. 2001: 4). See also Gray (1992).

defining and implying each other, thus being on the same ontological footing.<sup>17</sup> Besides, any entity can, and indeed must, be viewed both

- (i) as a *relatum* (or interactant) regarding the extrinsic relations that it continuously entertains with other entities/relata in its environment; and
- (ii) as a global *relation* of the intrinsic local relations that continuously undergo between its component parts/relata.

Finally, in the course of such networks of ongoing relational processes, new types of relations, relata, and relational systems are continuously generated, destroyed and transformed, while different levels of composition and organization are formed.

Obviously, not all relations reach the point of producing a qualitative or a substantial kind of change (to use the Aristotelian terminology) in their interactants, and indeed in some cases we can explain—at least in a first approach—a given phenomenon in terms of a certain set of compositional or additive relations among different components or causes. Nevertheless, there are also indisputable cases of ontological emergence where we can only explain a given phenomenon as being the direct product of qualitatively transformative relations among some component parts or partial causes.

So, instead of mere organizational emergence or contextual emergence, what we need is a genuine '*relational–transformational* emergence'. The qualitative change of component parts or relata through their own interactions is the key mechanism that engenders any emergent systemic property or behavior.

Therefore, we must be cautious with the nature of this new ontological proposal, otherwise emergentism can fall into a mere special kind of preformationism that we have called potentialism. Emergent phenomena are not actualizations of latent or potential phenomena pre-existing at lower levels of organization, or in preliminary stages of developmental processes. Moreover, what could we mean by that? Could we defend that molecules actualize the emergent properties of life, once they are integrated in cells? Likewise, although we may consider the possibility of threshold effects within gradualist approaches to consciousness, it seems inconceivable that nerve cells, such as neurons, begin to think and to have self-consciousness when they get involved in some neural networks.

Life is not a system's components latent micro-property or micro-power activated by some emergence-engendering way, as Shoemaker puts it. Likewise, no mental state exists already in potency at the level of each nerve cell, since no single neuron begins to think about himself when it gets involved in some relational context with other neurons, but they rather have the capacity to qualitatively transform each other in certain relational contexts in such a way that the *system* they compose—the brain, as the center of the nervous system—acquires new qualitative properties, activities, causal powers and behaviors that do not exist at the level of its components. In short, emergence is not the transition from potency to act, even though this kind of change, at the level of each individual component of a relational system, is a necessary *prerequisite* for the occurrence of genuine ontological emergence at the level of a system taken as a whole.

The most we can say is that the conditions of possibility for the occurrence of emergent systemic properties already exist in the nature of the systems' components. But one thing is to say that some molecules have the possibility of reciprocally affect each other in a way that the system they compose, the cell, acquires vital properties such as the capacity to self-replicate,

<sup>17</sup> Furthermore, unless abstraction is involved, no relatum exists without being related to something else, and no relation instantiates without relating some relata. Accordingly, I don't subscribe to the ontological structural realism in either its eliminative or moderate versions. See [Chakravarty \(2003\)](#).

another thing is to say that molecules have already in themselves, latent, the characteristics and capacities that are only performed by cells and living organisms.

Emergent properties are systemic properties that are generated by the qualitatively transformative interactions between system's components and, consequently, by the new relational properties that the components exhibit in such networks of qualitative codependency.<sup>18</sup>

Accordingly, the 'instantiation base' of any emergent property is always a particular relational system of codependent transformations, and the emergent property can be explained by the set of causal interactions between the transformed components, by their new relational properties and, consequently, by their new law-like behaviors. A new causal and/or nomological meso-level is thus produced interposing between the micro-level of the low-level system's components and the macro-level of the emergent properties of the system taken as a whole.

Consequently a new level of explanation arises. And that is the reason why emergent systemic properties cannot be reduced or explained away in terms of the low-level theory of the original components with their own previous intrinsic properties (the ones that they manifest when they are taken separately or in ideal-typical conditions), only adding compositional laws and only considering quantitative variations, as part-whole microphysicalism and its atomistic ontology demand.

Hence, there is no need to suppose the existence of a complete disintegration or 'fusion' process of the components within an emergent whole, as it was proposed by Humphreys (1997b). Although such a kind of change may happen, ontological emergence does not necessarily imply that the original elements lose their complete identity in forming the new emergent whole. Furthermore, even when such kinds of changes do occur, they are only the final result of previous qualitative transformation processes.

Besides, Humphreys is certainly right when he affirms that "[e]mergence has considerable philosophical importance because the existence of certain kinds of ontologically emergent entities would provide direct evidence against the universal applicability of the generative atomism that has dominated Anglo-American philosophy in the last century" (Humphreys 2006: 190). Nevertheless, he ends up defending a holistic view of emergence where there is no emergence base (the lower level entities go out of existence), and, consequently, there is no relational structure or causal mechanism that can explain the maintenance itself of the emergent system. By way of contrast, Paul Teller's relational holism is closer to our relational perspective, since his holism preserves the possibility of identifying two distinct individuals, while acknowledging the fact that they stand, at the same time, in some inherent relations to each other (Teller 1986: 73).

In this sense, over and beyond atomism and holism, emergence theory advocates right from the start a relational perspective, according to which it is neither the individual elements, as self-sufficient atoms with their own intrinsic essential identities, nor the wholes, as mysterious self-imposed entities that come about in a manner one knows not how to account for, but rather the relations that qualitatively transform the elements and by which the whole, as a

<sup>18</sup> As Sunny Auyang observed, "[w]hen we say a system's emergent character differs not only quantitatively but qualitatively from the character of its constituents, *quantitative* has a more general meaning than that regarding amount or size. (...) An individual has various characters, the summary of which is called the individual's *state*. The general concept of a character can be analyzed into two elements, a *type* and a *value*. Blue and red are values of the character type color; big and bigger, values of size. Other characters are temperature, weight, and annual income; their values  $-25^{\circ}\text{C}$ , 250 Kg, and \$25,000—are the definite predicates attributed to individuals, and their types are represented in the units: degrees Celsius, kilogram, and dollar." (Auyang 1999: 177 and 49).

relational totality, is constructed, that which is to be considered crucial in the explanation of reality. Relations are thus posited as the primary objects of research.<sup>19</sup>

Nevertheless, atomistic metaphysics is, of course, still well alive. The mereological supervenience theory, as formulated by Jaegwon Kim, is a clear example of the survival of this metaphysics:

(...) supervenience theses, when applied to the layered model, turn into claims of mereological supervenience, the doctrine that properties of wholes are fixed by the properties and relations that characterize their parts. A general claim of macro-micro supervenience then becomes the *Democritean atomistic* doctrine that the world is the way it is because the microworld is the way it is. (Kim 1998: 18).<sup>20</sup>

The same can be said about David Lewis' Humean supervenience theory, defined as "the thesis that the whole truth about a world like ours supervenes on the spatiotemporal distribution of local qualities" (Lewis 1994: 473):

[Humean Supervenience] is the doctrine that all there is to the world is a vast mosaic of local matters of particular fact, just one little thing and then another. (...) We have geometry: a system of external relations of spatiotemporal distance between points. Maybe points of spacetime itself, maybe point-sized bits of matter or aether or fields, maybe both. And at those points we have local qualities: perfectly natural intrinsic properties which need nothing bigger than a point at which to be instantiated. For short: we have an *arrangement* of qualities. And that is all. There is no difference without difference in the arrangement of qualities. All else supervenes on that (Lewis 1986: ix–x).

As it is easy to see, Kim and Lewis conceive relations in a mere atomistic/combinatorial way, in terms of spatial dispositions and mereological arrangements, and not as genuine transformative interactions that are able to qualitatively change their relata. In fact, it is precisely this metaphysical impossibility that blocks the possibility of ontological emergence.

## 6 Autonomy and Dependency

Having said this, how can we make sense of the idea that an emergent phenomenon is constituted, generated from, and dependent on, some set of previous or underlying agents,

<sup>19</sup> This is basically the relational perspective explicitly defended by Jean Piaget since the 40s of the twentieth century. Piaget's relational perspective also explicitly refers to the constructive and transformative power of interactions, as it is easily understandable given his characterization of the very notion of structure as "a system of transformations" (Piaget 1971: 8–9 and 97–99), and given his view that "the idea of *structure* as a system of transformations becomes continuous with that of *construction* as continual formation." (Piaget 1971: 34). In his time, Piaget criticized classical emergentism because he identified it with a kind of mysterious holism: "The whole which this sort of critic of atomism posits at the outset is viewed as the outcome of some sort of emergence, vaguely conceived as a law of nature and not further analyzed" (Piaget 1971: 8). Indeed, in this approach, the modes of formations and the modes of operations of the so-called emergent wholes are "left unspecified". In the last analysis, Piaget considers classical emergentism an inconsequential theory, because "to note the existence of wholes at different levels and to remark that at a given moment the higher 'emerges' from the lower is to locate a problem, not to solve it" (Piaget 1971: 46). The same kind of criticism to classical emergentism can be found, more recently, in Bechtel and Richardson (2010: 94–95).

<sup>20</sup> As Kim observes, "it is useful to think of mereological supervenience and microdeterminism as constituting the *metaphysical basis* of the method of micro-reduction and micro-explanation. By this I mean that the metaphysical doctrine rationalizes our micro-reductive proclivities by legitimizing micro-reduction as a paradigm of scientific understanding and helping to explain why the micro-reductive method works as well it does." (Kim 1993: 102).



and, at the same time, somehow autonomous from, and irreducible to, those very agents? How can we avoid this putative inconsistency?

As Mark Bedau observed, this seems “metaphysically problematic, inconsistent or illegitimate or unacceptably mysterious”. Besides, those two features are vague, since “there are many ways in which phenomena might be dependent on underlying processes, and there are also many ways in which phenomena might be autonomous from underlying processes” (Bedau 2002: 6; Bedau 1997). How can we thus clarify the concepts of dependency and autonomy, so that they become compatible?

According to the relational perspective defended here, there is the need to distinguish between two different dimensions of the so-called ‘emergence base’, being thus possible to avoid the contradiction of saying *simpliciter* that an emergent phenomenon is both dependent on, and autonomous from, the same basis.

The emergence base is as a *bi-dimensional* reality. Any emergent systemic property is instantiated by a specific kind of relational system (e.g. a cell) that is necessarily composed by a set of constituents (membrane, cytoskeleton, proteins, nucleic acids, for example) endowed with their own defining properties. This is the necessary *compositional* dimension of any emergence base. Nevertheless, this dimension does not offer the sufficient conditions for the occurrence of an emergence process, since we have to add a further dimension that corresponds to the set of qualitatively transformative interactions between those constituents, the relational properties that arise through such interactions, and the new laws that account for them. That is why the new law-like behaviors that emerge at the level of the system’s structure are qualitatively different from the ones that govern the original components taken in an ideal isolated state or in other kinds of relational contexts.<sup>21</sup>

Without contradiction, the emergent properties of any given system are thus relatively autonomous from the compositional dimension of its emergence base, being at the same time directly dependent on its *relational-transformative* dimension.

An emergent systemic property is said to be ontologically autonomous or independent from the activities of the system’s constituents iff it derives, not from the simple aggregation, modes of composition and quantitative relations of their individual monadic properties, but directly from the network of the transformative relations among the constituents.

In fact, it all depends on the way we approach the so-called base elements and their relations. And here is where enters the atomistic versus the relational views of reality and the correlative notions of explanation, the options being a part–whole micro-reductive explanation in terms of modes of composition and quantitative interactions among qualitatively fixed individual entities, and a model where any systemic phenomenon is to be explained in terms of the relational–transformational system’s causal network. If the relations among the components qualitatively change and influence their properties, then the behavior of the system as a whole will be relatively autonomous from, and irreducible to, the sum of their individual behaviors taken separately. But if we take instead the sum of the constituent’s behaviors already transformed and coercively influenced through their own relations, then the systemic features will obviously be the direct expression of, being fully reducible to, the sum of those very activities and relations with no remainder.

The relative autonomy or independency of a high level system or systemic behavior in relation to its low level constituents’ behaviors is therefore to be judged according to whether

<sup>21</sup> For example, As Evelyn Fox Keller has said, “the properties of a cell, for example, are at least partly determined by transcription of DNA but, in turn, cellular properties also determine which sequences are to be transcribed, in which combinations, and in what order. Indeed, the very definition of what (if anything) a gene *is* depends on the properties of the cell in which the DNA is embedded” (Keller 2010: 30). See also Powell and Dupré (2009).



we observe the effects of the qualitatively transformative and coercive power of the relations upon the identities and behaviors of the relata taken as individual entities (this being what is traditionally, and somehow puzzling, called downward causation, see Santos 2014).

Furthermore, it is obvious that not all changes in the local interactions among the constituents will immediately cause a qualitative change in the global state of the system they compose. Within some limits, local microstate changes are perfectly compatible with the persistence of the system's global state, and only when some quantitative (critical) limits in the parameters that characterize the constituents' behaviors are exceeded can a sudden qualitative change (a threshold effect) occur in the system.<sup>22</sup>

## 7 Conclusion

A naturalistic account of ontological emergence can only be established by explicitly denying the fundamental post-Eleatic tenet of the absolute intrinsicness of the qualitative identity of every entity, and the correlative idea that any extrinsic relation is only a matter of combinations, rearrangements and quantitative co-variations among elements qualitatively unchangeable. Therefore, emergence is a qualified form of autonomy and irreducibility that only makes sense against the backdrop of an atomistic ontological–epistemological perspective, according to which all entities' properties and behaviors are micro-reducible to the set of the intrinsic and essential properties of the entities' constituents (since they are not supposed to change) in addition to some laws of composition and mere quantitative co-variation of those properties.

In direct opposition to this atomistic framework, a theory of ontological emergence must thus be grounded in a relational perspective, according to which all entities' type identities and behaviors are constructed by their intrinsic and extrinsic relations. That is the reason why we can take the in-principle impossibility of part–whole micro-explanatory reductionism as the hallmark of ontological emergence. And the moral that follows from this is that we ought to overcome the epistemological approaches based on the atomistic ideal worldview, under the guidance of linear superposition principles in Physics, or of methodological individualisms in the Social Sciences.

With the notion of ontological emergence here proposed we are able to give an answer to one of the most important unresolved issues for emergentism, according to J. Kim, that is, that of giving a positive characterization of emergence in terms of the explanatory irreducibility of emergent phenomena as a genuine relation characterizing two domains of properties, or two theories (Kim 2006a). Any systemic emergence process is produced by, and dependent on, a specific network of qualitatively transformative interactions, being thus explainable in terms of those very causal interactions and reciprocal changes, and of the laws which describe them in terms of the new components' relational properties.

Hence, as we can affirm that an emergent phenomenon is unexplainable, irreducible, and unpredictable 'in principle' if that phenomenon is addressed in atomistic terms, we can also conversely affirm that from a relational perspective, any emergent phenomenon can be explained and predictable 'in principle' in terms of its underlying or previous intersecting transformative processes, and the most we can get are practical problems given the intrinsic complexity of the phenomena and our cognitive limitations—problems that nevertheless can be overcome by further scientific and technological developments (Santos 2013). Indeed, there is only mystery, incoherence or epistemological skepticism about the notion of ontological emergence if we insist on an atomistic mode of thinking.

<sup>22</sup> See the notion of 'dynamic autonomy' as characterized by Wimsatt (2007: 216–221).

This, in short, is how one can avoid the usual negative characterizations of emergence, and how “neo-emergentists” can surpass “classical emergentism” (pace Kim 2006a: 556 n. 5), denying the simplistic atomistic conceptions of relation, causality, reduction and explanation, while still adopting an entirely naturalistic notion of emergence.

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