

# When the part mirrors the whole: interactions beyond simple location

Alex Gomez-Marin<sup>1,\*</sup> Juan Arnau<sup>2</sup>

<sup>1</sup> *Behavior of Organisms Laboratory, Instituto de Neurociencias CSIC-UMH, Alicante, Spain*

<sup>2</sup> *Facultad de Filosofía y Letras, Universidad de Granada, Granada, Spain*

\* Correspondence: [agomezmarin@gmail.com](mailto:agomezmarin@gmail.com)

## Abstract

Reductionists believe that we can make sense of the whole in terms of its parts. Emergentists react and reply that the reductionist program is unattainable partly due to the existence of emergent properties. Under the celebrated banner “the whole is more than the sum of its parts”, such holistic stance is particularly relevant to the study of life and mind, where interactions amongst system components and environment are key. However, both antithetical tendencies (reduction and emergence) often betray a commitment to what Whitehead called *simple location*, the idea that things are simply where they are. Here we show the problematic consequences of adopting such a view when trying to understand physical, biological and psychological identities. Dynamic interactions indeed denote “togetherness”, yet they are *external*: no matter how much one is eager to emphasize their role, each element that inter-acts still exists and can be thought regardless of any essential reference to other bits of matter. We uncover and reject such stance. We then propose an alternative based on Whitehead’s philosophy of organism. The doctrine of *internal relations* allows conceiving each relationship entering into the essence of an entity. This entails the idea that every part mirrors the whole, which needs to be qualified. We end by discussing the problem in the context of abstraction, and draw basic implications for a theory of perception. In sum, taking an *event*-notion of individuality, we propose to think “inter-identities” beyond the assumption of *simple location*. We are not enduring interacting substances, but internally related processes.

**Keywords:** simple location, internal relations, interaction, identity, perception

*“Berkeley afirma: Sólo existen las cosas en cuanto se fija en ellas la mente.  
Lícito es responderle: Sí, pero sólo existe la mente como perceptiva y meditadora de cosas.”  
(Borges, 1925)*

*“It has been usual, indeed, universal, to hold that spatio-temporal relationships are external.  
This doctrine is what is here denied.”  
(Whitehead, 1925)*

## 1. INTRODUCTION

What happens when we bite an apple and experience its flavor? Berkeley, the Irish empiricist, would suggest that the flavor of the apple is not to be found in the apple itself, nor in the person that tastes it, but in the gathering of both (**Berkeley, 1710, I.1**). This is not only applicable to flavor, it can be extended to a wide range of perceptions and thoughts. Actually, an apple is also the confluence of a seed, a tree, a sprout, the rain, and the harvest. The same can be said of someone’s parents, a language, hunger, or a piece of art. What we call “things” are actually processes whose origin becomes impossible to trace. Things are encounters.

Identities are crossroads. The flavor is not different from the other encounter we call person. The things we perceive and imagine are gatherings and they all have a provisional character. Such essential conditionality is what Buddhists call emptiness. Accordingly, one cannot say that the truth of the fugacity of things is an eternal truth, otherwise it would transform it in a product of the same kind as that which it denounces. The truth of the provisionality of identities is itself provisional and gets involved with a certain character of irony (passing truth has a soothing effect on imagination). This brings us directly to the core of the problem of identity:  $A=A$  is either a truism or false.

In fact, one of the most original ideas of the ancient Mahayana Buddhism (**Nāgārjuna, 2011, 2.19, 6.4-5, 10.16, 20.19-20**) was its critique of the notion of identity: there are not two identical things in nature; nothing is identical to another thing. According to this view, identity is impossible;  $A=A$  is a fallacy. If one can't find in the world two equal beans, two exactly same cogs, even less two identical hopes or living beings. Not only there are no two equal grasshoppers, but, since they live in time, each grasshopper could never be identical to itself. The person that started read this paragraph is not the same than the one who finishes it.

Yet, the idea of identity has not ceased to obsess the modern imagination. Physicists of the 20th century went after it by decomposing matter. Carried away by an architectonic metaphor (which became an “architectonic delusion”), they thought that decomposing things into their fundamental elements would reveal the “bricks” of the real; all simple, all identical. Biology — imitating the model of Physics— set itself the same agenda (notably, and ironically, at the same time when Physics itself was realizing its futility): to search for what organisms are by breaking them into tissues, then tissues into cells, and cells into proteins. Nearly a century later, many still think that the secret of life is a handful molecules that code for it (and similarly for neurons and the secret of mind).

Interestingly, biologists did not go further since once one dives inside the molecule, quantum physics changes the game. The intellectual courage of physicists taught us that when you get to the smallest bit, the universe does not look like a uniform pile of bricks, but actually like a zoo of particles within exotic families, ultimately the expressions of activity. Why call them elemental, if there were so many (6 quarks, plus 6 leptons, plus 4 gauge bosons, plus the Higgs)? And, why call them particles, if it is not really possible to localize them or distinguish them from the field in which they move, and from which they appear and disappear? Thus, some researchers preferred to call them field perturbations. Stability became a by-product of activity; the elemental, an expression of the perturbed. Substances —upon which Western thought is literally built— turned out to be stabilized processes.

Today we know (despite we can hardly conceive) that there is no such thing as two identical electrons. The reason is simple: it is not possible to delineate the entity we call electron. We do not know where it starts nor where it ends. The electron is the expression of a force in a field, whose localization would in turn become problematic. To that Whitehead adds a puzzling note: “an electron within a living body is different from an electron outside it, by reason of the plan of the body” (Whitehead, 1925, p.79). We will come to this later.

The following passage from Whitehead's *Process and Reality* is very clear on this respect, and so we take the liberty to quote it at length: “Thus in framing cosmological theory, the notion of continuous stuff with permanent attributes, enduring without differentiation, and retaining its self-identity through any stretch of time however small or large, has been fundamental. The stuff undergoes change in respect to accidental qualities and relations; but it is numerically self-identical in its character of one actual entity throughout its accidental adventures. The admission of this fundamental metaphysical concept has wrecked the various systems of pluralistic realism. This metaphysical concept has formed the basis of scientific materialism. For example, when the activities associated with so-called empty space required scientific formulation, the scientists of the nineteenth century produced the materialistic ether as the ultimate substratum whose accidental adventures constituted these activities. But the interpretation of the stone, on which the whole concept is based, has proved to be entirely mistaken. [...] The stone is now conceived as a society of separate molecules in violent agitation. But the metaphysical concepts, which had their origin in a mistake about the stone, were now applied to the individual molecules. Each atom was still a stuff which retained its self-identity and its essential attributes in any portion of time— however short, and however long— provided that it did not perish. The notion of the undifferentiated endurance of substances with essential attributes and with accidental adventures! was still applied. This is the root doctrine of materialism: the substance, thus conceived, is the ultimate actual entity. But this materialistic concept has proved to be as mistaken for the atom as it was for the stone. "The atom is only explicable as a society with activities involving rhythms with their definite periods. Again the concept shifted its application: protons and electrons were conceived as materialistic electric charges whose activities could be construed as locomotive adventures. We are now approaching the limits of any reasonable certainty in our scientific knowledge; but again there is evidence that the concept may be mistaken. The mysterious quanta of energy have made their appearance, derived, as it would seem, from the recesses of protons, or of electrons. Still worse for the concept, these quanta seem to dissolve into the vibrations of light” (Whitehead, 1929, p.78-79).

Let us go back to experience. Draw a circle or, if you wish, think about it. It is always a particular circle, this and not that; one and not any. See the moon in the black sky of the night. Call it a sphere, if you may. Thus, if one does not want to renounce to thought, the only option seems to succumb to the geometric temptation. If words take for granted an identity that is nowhere, their exercise and manipulation would consist in abstraction: in solidifying what has a dynamic nature, and in forgetting the differences of the particular in order to attend to the general.

The recognition of this fact should not provoke the search of new identities — all fake and fictitious, or literally entelechies, all the result of the confusion that language produce on us. In an abstract world, a perfect circle is possible and all circles are exactly the same, their perimeters obeying the same law. So, the question is about abstractions. In an effort to organize experience, we distort it.

Let us now consider this example (more appropriate to the issue of inter-identities): We see a cat running after a mouse. While in interaction, both the cat and the mouse seem to be obviously separate. But, to what extent is their mode of existence non-trivially separate? In what follows we will attempt to show the scotoma that stems from the principle of individuation.

Locke's *principium individuationis* states that “the only thing which differentiates one atom from all others is its spatial location at a certain particular instant and nothing else” (Locke, 1689, II:XXVII). Differences are thus only differences in spatial location. This entails the possibility to endow a “definite portion of space with well-defined boundaries”. From Descartes, we read: “by substance we can understand nothing other than a thing which exists in such a way as to depend on no other thing for its existence”; *Per substantiam nihil aliud intelligere possumus, quam rem quae ita existit, ut nulla alia re indigeat ad existendum* (Descartes, 1644, I. 51). Something is what it is in virtue of its being in a defined region of space where there is not another thing, at a particular instance, and without needing any other things for its existence. Hence the encysted problem of interaction between substances (*res cogitans* and *res extensa*); the problem of bringing a material universe made of *res extensa* to its ultimate consequences. How does one substance affect another? It cannot (by definition). One may only displace it. The rejection of dualism by means of materialism finds a dead end. If the world is made of stuff whose existence does not fundamentally care about other existences, the universe becomes a soup of dull monads. Once substances are posed as building blocks of the universe, the universe ceases to make sense as it becomes a poorly glued pile of static mini-universes.

The Cartesian conception of reality —upon which the majority of sciences are still based— is that of “bricks and mortar”, atoms and their interactions. Note that the mortar does not change the brick in any way, but just its external relationship with other bricks in space. A brick remains a brick, regardless of all the other bricks. Each brick of reality has a place, where no other brick can be. That is what, according to Locke, gives each brick its identity. Bricks are what they are by virtue of their instantaneous being there. Then, any mode of thought based on a substance ontology easily lends itself to materialism, reductionism and also mechanism: the world is made of (and reducible to) building blocks, which are all physical, each occupying a different place in space, and with a spatiotemporal location that grants them their identity. Furthermore, being external to one another, their identities are, in essence, independent.

How to avoid a completely disconnected universe? One may add the possibility of every bit of stuff to act on every other bit. But, as we saw, such action can only be a displacement in space: A pushes B. Thus, in a world made of particles, their relationship occurs via inter-actions. Interactions are mechanical insofar as the type of change allowed is not transformation but re-arrangement. In sum, the spatial configuration of the elements can change; their inner natures cannot. In such a world, differences in kind must thus be apparent. All change is due to the displacement of discontinuous, rigid, compact units guided by mechanical laws. They are what they are by virtue only of themselves, and they will remain what they are by virtue only of themselves: located in space and unchanging in time. It is a universe that “reads Braille”: the only way to know of each other is by touch, by direct impact. Like Saint Thomas, the expression “what I do not see I do not believe” is actually superseded by “touch to believe”. The cosmos is then conceived as a great billiard board of *simply-located particles*, as Whitehead would put it. Each bit of matter is, by construction, individually independent. It is “regarded as fully describable, apart from any reference to any other portion of matter” (Santos & Sia, 2007, p.91). From this worldview, any relation to another entity is always secondary. Ironically and paradoxically, relations are both deprecated and at the same time necessary to glue the world together. In a world that is only externally related, inter-identities, seriously considered, become an oxymoron.

## 2. SIMPLE LOCATION

What is the foundational assumption upon which this notion of identities rests, and which at the same time creates so many theoretical problems? Whitehead argues that it is *simple location*: “The Ionian philosophy asked, What is nature made of? The answer is couched in terms of stuff, or matter, or material —the particular name chosen is indifferent— which has the property of simple location in space and time, or, if you adopt the more modern ideas, in space-time. What I mean by matter, or material, is anything which has this property of simple location. By simple location I mean one major characteristic which refers equally both to space and to time (...). The

characteristic common both to space and time is that material can be said to be *here* in space and *here* in time, or *here* in space-time, in a perfectly definite sense which does not require for its explanation any reference to other regions of space-time. (...) and, so far as simple location is concerned, there is nothing more to be said on the subject” (Whitehead, 1925, p.49).

Thus, *simple location* is the notion that there are portions of matter that are fully describable apart from any reference to any other portion of matter, so that any relation to other entities, existing or not, is secondary. Relations thus cannot really say anything about the internal constitution of that bit of matter. For space, it means that there can be entities in a vat. For time, it means that change is sequential, not serial. Both imply a fundamentally disconnected universe in space and in time. The acceptance of *simple location* is what distinguishes modern science and philosophy. Both rest upon it: “the element in this scheme that we should first criticize is the concept of simple location. (...) To say that a bit of matter has simple location means that, in expressing its spatio-temporal relations, it is adequate to state that it is where it is, in a definite finite region of space, and throughout a definite finite duration of time, apart from any essential reference of the relations of that bit of matter to other regions of space and to other durations of time. (...) This idea is the very foundation of the seventeenth century scheme of natural” (Whitehead, 1925, p.58).

Simple location is intrinsically related to the notion of mass. Mass is literally the cornerstone of physics, and of the very process of measurement. It is also the foundation of scientific realism, as it effects the separation between primary and secondary qualities. All that is mental is, by postulate, not primary; it does not really count. All that matters is matter; as for mind, never mind. The universe is not only intrinsically disconnected, it is also tasteless (one could argue that this philosophy of nature contributes to depression, but it should not matter to those who profess it because depression is not a primary quality of the universe anyways, nor of the beings living in it).

Within the well-ingrained rhetoric of the elemental, elements are both principles and rudiments. The world is thought to be literally made of impenetrable little balls bouncing all around. In Čapek's words: “One and the same particle cannot be at the same time in two different places and two different particles cannot occupy one and the same position at the same time; if they do, they cease to be different and their twoness itself disappears. Or, more accurately, to speak of two different particles being simultaneous at one and the same location, means to apply two different names to a simple entity. It is clear that in the property of simple location two basic features of classical science are united: the assertion of *impenetrability of matter* as well as *the denial of action at a distance*” (Čapek, 1991, p.197).

Once with simple location, several scientific and philosophical problems ramify: how to conceive memory, causation, induction, and evolution? Since the present is (like the particle in space) external to itself, the past is excluded from it. By which artifice can it be linked back? Moreover, as there are no instantaneous interactions, only the past can act on each particular event. If we take simple location seriously, the movement of a particle becomes impossible. If each configuration of matter has no inherent references to any other place or time, if nature is really like this, external to herself, then induction is not based on anything inherent in nature. Moreover, “the notion of 'simple location' is inconsistent with any admission of 'repetition'; Hume's difficulties arise from the fact that he starts with simple locations and ends with repetition” (Whitehead, 1929, p.137). The consequences that Hume pointed out were correct, had his premises been true. Simple location causes serious problems to induction as well.

Furthermore, external relations do not allow for evolution. A doctrine of *internal relations* is necessary if one is to have something else than mere unfurling (Gomez-Marin, 2019): “The aboriginal stuff, or material, from which a materialistic philosophy starts is incapable of evolution. This material is in itself the ultimate substance. Evolution, on the materialistic theory, is reduced to the role of being another word for the description of the changes of the external relations between portions of matter. There is nothing to evolve, because one set of external

relations is as good as any other set of external relations. There can merely be change, purposeless and unprogressive. But the whole point of the modern doctrine is the evolution of the complex organisms from antecedent states of less complex organisms. The doctrine thus cries aloud for a conception of organism as fundamental for nature. It also requires an underlying activity—a substantial activity—expressing itself in achievements of organism. The organism is a unit of emergent value, a real fusion of the characters of eternal objects, emerging for its own sake” (Whitehead, 1925, p.107).

There are other reasons to reject simple location. Identity, as the quality of being the same to oneself, leads to the following situation: A may interact with B, and some properties of A may even be affected; but A will still remain equal to itself. If substances (by definition externally related) are the most fully real, and enduring things are self-identical through time, then you are strictly identical with your past and future selves. No true development can occur. An ethics in which your relationship with others is fundamentally different than with yourself seems doomed to fail.

Emergentism tries to correct reductionism with the help of mereology. This is certainly important, as we need to be able to distinguish between different senses of “parthood”. How the parts relate to the whole is what is at stake. Is the whole prior to its parts? If so, is it logically or ontologically? Yet, those who reject reductionism but still adhere to materialism by emphasizing the whole (Gilbert & Sarkar, 2000) perhaps unknowingly do so in order to save the idea of *simple location*. They may trust that by supplementing the parts with dynamic interactions one can ameliorate the situation. The adoption of simple location is a major drawback to the commendable “fix” of emergent properties. Emphasizing interactions of otherwise simply located elements does not bring forth a more internally related universe. Let us articulate it first in a metaphorical way: the taint of simple location cannot be cleansed by rubbing; the cloth must be abandoned. The problem of interactions is itself problematic.

Let us revisit the concept of mass to see how holistic narratives can still carry out the baggage of the notion of simple location: “Newton defined it as *vis insita*, that is, literally, as *force residing* within the location occupied by matter and constituting, so to speak, its substantial nucleus which is related *externally* to other particles. The belief in the simple location of sharply defined corpuscular entities could have hardly found more accurate formulation: the essence of material particle is its resistance to acceleration, reacting *hinc et nunc* against the *external* influences of other equally well defined corpuscular entities” (Čapek, 1991, p.209). Čapek then quotes physicist and philosopher Ernst Mach’s criticism of Newton: in the principle of inertia there is “an abbreviated reference to the entire universe” and that “the neglecting of the rest of the world is *impossible*” (Čapek, 1991, p.210). We ask what is simple in an atom, electron or stone, and we realize that, when we knock at the door and open its bricked window, what lies inside is virtually the whole universe.

The critique extends not only to mass but also to interactions: “to isolate one particle and force from the whole dynamical context is as artificial as to claim that buying may take place without selling” (ibid). Maxwell saw that Newton’s 3rd law unifies action and reaction as one dynamical phenomenon: *stress*. Action and reaction are two opposite effects of the same reality, in the same way that in “commercial affairs the same transaction between two parties is called Buying when we consider one party, Selling when we consider the other, and Trade when we take both parties into consideration” (Maxwell, 1992, p.27). For Faraday, “matter is not merely mutually penetrable, but each atom extends, so to say, throughout the whole of the solar system, yet always retaining its center of force” (Faraday, 1839).

After Faraday and Maxwell, modern physics irreversibly stumbled upon the problems that *simple location* creates. In fact, a century ago such concept was left virtually unrecognizable after Relativity Theory and Quantum Theory. Due to the principle of indeterminacy and entanglement, precise boundaries became ill-defined and particles could not be localized anymore. From physics to psychology, James and Bergson had started to dismantle it a few years

earlier. Whitehead bluntly denied the concreteness of simple location. He did not prune it; he pulled it out from its root. Let us see how.

### 3. INTERNAL RELATIONS

That the properties of A depend on B is acceptable. But claiming that the essence of A depends on B actually defies the intellect. Our intention here is to think identity, intrinsically relational. This seems possible by means of Whitehead's *event*-notion of individuality, and his doctrine of *internal relations*:

The negation of *simple location* is accompanied by an affirmation. Whitehead puts forth the notion of *internal relations*<sup>1</sup>, which he introduces when discussing Einstein's relativity: "The theory of the relationship between events at which we have now arrived is based first upon the doctrine that the relatedness of an event are all internal relations, so far as concerns that event, though not necessarily so far as concerns the other relata. For example, the eternal objects, thus involved, are externally related to events. This internal relatedness is the reason why an event can be found only just where it is and how it is, that is to say, in just no definite set of relationships. For each relationship enters into the essence of the event; so that, apart from that relationship, the event would not be itself. This is what is meant by the very notion of internal relations. It has been usual, indeed, universal, to hold that spatio-temporal relationships are external. This doctrine is what is here denied" (Whitehead, 1925, p.122-123).

Put plainly, an internal relation is a relation between entities such that it is not possible for them to exist without each other. Thus, from the stance of the doctrine of internal-relations, inter-actions are "add-ons" to substances; a glue between "things" that do not need the glue for their being. We are seeking here a rationalization, as well as examples, of how A and B can or may be related so that their relation is primary. Thus, one could not and should not speak about A if one leaves B out (because it owes to B what it is). Secondly, an internal relation also entails that the essence of A is due to its relation to B, and vice versa. Namely, an internal relation is a relation that determines the essence of related beings.

The first point would be easily satisfied by a baby (born, but specially a fetus) with respect to his (pregnant) mother—or, for that matter, with respect to sufficient human, and even animal care—but without necessarily invoking the second point. Amongst other examples for entities whose existence is intrinsically relational we find the bee and its hive. Another example that may belong to the tentative list we are now building for the purpose of gaining intuition about the notion of internal relations is quantum entanglement; notably for purely physical systems A and B which, despite not being in interaction at the present time, are inseparable (beyond shared memory). Escher's hands drawing each other may serve as a visual analogy to attempt a visualization of internal relations. Ouroboros, the serpent that eats its own tail, is another. A curious gathering is a magic trick, since there is no magic without the magician and at least one spectator (it is easy to fool oneself, but it is impossible to do a magic trick to oneself). The sound of one hand clapping also induces a paradox that could help conceptualize internal relations. Along similar lines, let us mention *The Real and its Double* (Rosset, 1976).

---

<sup>1</sup> Internal relations do not denote a contrast between inside and outside (internal versus external), but between intrinsic versus extrinsic. Moore discussed *internal relations* before Whitehead, but not in the same sense (Moore, 1919). Let us also note one must be cautious with some definitions of the notion of *internal relation*, especially when provided by analytic philosophers, influenced by Russell (see for instance Stanford Encyclopedia for Philosophy about internal and external relations). He thought that internal relations determine the related beings and thus make freedom impossible. Russell favors external relations. He did not (and probably would not) think in terms of transformation of essence. Yet, self-determination of human essence through internal relations to other essences is arguably the highest form of freedom.

Some possible examples for the notion of internal relations as determining of the essences of the beings in relation are the following (briefly enumerated here, in the interest of brevity and of avoidance of excessive technicality): Bergson's interpenetrating experiences of our *durée*; Whitehead's prehensions between actual occasions; Sartre's claim that human existence transforms its essence; Maria and Jesus Christ; and The Trinity: Father, Son and Holy Spirit. In turn, one could argue that Hegel anticipates Whitehead's doctrine of internal relations, and that the Christian doctrine of the Trinity is another of example of it; in fact, the idea of absolute spirit, universals, and actual entities is omnipresent in idealist philosophy and religion (Hemsell, 2017). Being a recurrent product of logos, each of these philosophies is a restatement of the Same-Other reality.

In contrast, "things", as usually conceived by the layperson, the professional scientist and even the philosopher, are externally-related beings. As such, they cannot be concrete, and thus are abstractions (see section further below). One can then conceive things in external relation and still claim that it is impossible, for some of them, to exist without the other. Therefore, the real challenge is to conceive a mode of relation that determines not only the possibility of existence but the essence and identity of two "things". Process philosophy —at least in Whitehead's flavor, which we are trying to explicate here— undertakes such task.

Let us also note that a rigorous understanding of internal relations discards dynamical systems since their relations are external. For instance, the relation does not determine the essence of the related molecules in Rayleigh–Bénard convection, chemical systems, springs, electric circuits, coupled pendulums etc. The relation between coupled non-linear pendulums that behave self-organized or even deterministic chaotically is clearly external because they can be separated from each other without changing their essence (mass, shape) or ceasing to exist (Koutroufinis, 2014). In that sense, organicism is a necessary but not sufficient step away from mechanicism and reductionism. It is thus understandable that a "process-light" version of process-philosophy proper may remain dominant (an even become popular) due to the difficulty of thinking processes without turning them into dynamical systems (Jaeger & Monk, 2015; Dupré & Nicholson, 2018). At the bottom, such difficulty may be re-cast as our inability to conceive an internal relation.

\*

So, if things are not really where they are, does this mean that they are everywhere?

At first, this may seem a disproportionate claim. Whitehead's proposal is not so much that a particle is everywhere but that, in a precise sense, it also can and must be where it is not. The critique of simple location implies the negation of well-defined regions in space and time. Events are spread out, and also have temporal width. Their boundaries are fuzzy. Upon inspection, a "thing" is not everywhere but is indeed somewhere else. Whitehead's theory "involves the entire abandonment of the notion that simple location is the primary way in which things are involved in space-time. In a certain sense, everything is everywhere at all times. For every location involves an aspect of itself in every other location. Thus every spatio-temporal standpoint mirrors the world" (Whitehead, 1925, p.91).

In closely examining his critique of simple location, Čapek then qualifies Whitehead's "mirroring the universe" by means of emphasizing the causal cone of events: "each particular event reflects that part of the universe which acts on it as well as the potentialities of its own future effects; *but it remains causally unrelated to those events which neither act on it nor will be acted upon by it*" (Čapek, 1991, p.215). Thus, events are not simply located but at the same time they are circumscribed to causal influences. This supplements the principle of internal relations, and "limits the denial of simple location" (Čapek, 1991, p.218). In other words, "It is true that "each particular event mirrors the world," but we must not forget that 1. the term "world" must not be taken in the sense of timeless, complete entity; 2. that the act of mirroring *takes time*, that it is itself a time-consuming process" (Čapek, 1991, p.213).



Whitehead then adds a warning: “If you try to imagine this doctrine in terms of our conventional views of space and time, which presuppose simple location, it is a great paradox. But if you think of it in terms of our naive experience, it is a mere transcript of the obvious facts” (Whitehead, 1925, p91-92). Yet, simple location does not adequate to the concrete facts; it contradicts our immediate experience. There is no element apprehendable in immediate experience were simple location is to be found. A paradigmatic rebuttal often reads: “if our experience shows the contrary, so much worse for experience!” (Čapek, 1991, p.205).

#### 4. MISPLACED CONCRETENESS

The problem with simple location is not simple location. It is that we take such abstraction as concrete. In other words, the fundamental problem and error with abstraction is to confuse it with reality. This is what Whitehead called *the fallacy of misplaced concreteness*: “This simple location of instantaneous material configurations is what Bergson has protested against, so far as it concerns time and so far as it is taken to be the fundamental fact of concrete nature. He calls it a distortion of nature due to the intellectual ‘spatialization’ of time. I agree with Bergson in his protest: but I do not agree that such distortion is a vice necessary to the intellectual apprehension of nature. I shall in subsequent lectures endeavour to show that this spatialisation is the expression of more concrete facts under the guise of very abstract logical constructions. There is an error; but it is merely the accidental error of mistaking the abstract for the concrete. It is an example of what I will call the ‘Fallacy of Misplaced Concreteness’” (Whitehead, 1925, p.50-51).

Is this a denial of the reality of atoms? Yes and no. Atoms are both invented and discovered. No one has ever directly seen one. Yet, there is empirical evidence for them. However, as we have seen, upon close inspection, their essential properties crumble, as could have been expected<sup>2</sup>. In sum, they may be useful abstractions. The problem is to forget that “atomicity is only one aspect of nature” (Čapek, 1991, p.198). Abstraction is an operation of the intellect that assumes not only that things are isolatable but also that they are isolated.

Such is the peril of abstractions. The problem then lies when, upon abstraction, we take useful ideas as fundamental statements about reality. “The simple notion of an enduring substance sustaining persistent qualities, either essentially or accidentally, expresses a useful abstract for many purposes of life. But whenever we try to use it as a fundamental statement of the nature of things, it proves itself mistaken. It arose from a mistake and has never succeeded in any of its applications. But it has had one success: it has entrenched itself in language, in Aristotelian logic, and in metaphysics. For its employment in language and in logic, there is —as stated above— a sound pragmatic defence. But in metaphysics the concept is sheer error. This error does not consist in the employment of the word ‘substance’; but in the employment of the notion of an actual entity which is characterized by essential qualities, and remains numerically one amidst the changes of accidental relations and of accidental qualities. The contrary doctrine is that an actual entity never changes, and that it is the outcome of whatever can be ascribed to it in the way of quality or relationship. There then remain two alternatives for philosophy: (i) a monistic universe with the illusion of change; and (ii) a pluralistic universe in which ‘change’ means the diversities among the actual entities which belong to some one society of a definite type” (Whitehead, 1929, p.79).

---

<sup>2</sup> “Al descender hasta los microprocesos nos ha fallado el supuesto substancial; pero como íbamos cabalgando sobre los mismos procesos, haciendo caso omiso de su relación con una substancia, resulta que no nos hemos dado cuenta del cambio de corcel. Hemos abandonado la substancia y nos hemos quedado con la sola función. La sorpresa surge cuando se quiere atribuir substancialidad a los que eran simples comportamientos, o mejor dicho, meros cambios de propiedades de unas remotas substancias que ya no estaban inmediatamente “sustentando” los procesos elementales” (Panikkar, 1961, p.281).

Let us go back to Maxwell: “We are accustomed to consider the universe as made of parts, and mathematicians usually being by considering a single particle, and conceiving its relation to another particle, and so on. (...) To conceive a particle, requires a process of abstraction since all our perceptions are related to extended bodies, so that the idea of *all* that is present in our consciousness is perhaps as primitive an idea as that of any individual thing. Hence there may be a mathematical method in which we proceed from the whole to the parts instead of from the parts to the whole” (Maxwell, 1875).

Many abstractions are indeed useful. We are constantly abstracting in our daily life. If we want to take a train, we abstract from the train only that which is of our interest: schedule, price, destination. We do not attend to the color of the upholstery, the decoration of the toilets, or where the engine was made. And we do the same in our personal relations. The experience of thought (and desire) is an ongoing abstraction. Note that if what abstraction excludes is important to experience, then our modes of thought become inadequate.

If we are incapable of questioning —and eventually getting rid; or at least suspending for a period of time— of our usual abstractions, our work is condemned to sterility. As a group (scientific, or otherwise) we would literally live auto-enclosed and un-grounded. In this sense, the role that philosophy can play becomes decisive for science. The philosopher as the critic of abstractions is tremendously beneficial (and also, by default, painful) to the scientist. Paraphrasing von Weizsacker, each of us carries metaphysical assumptions, and those who deny this usually work with the poorest ones.

Abstraction solidifies reality. What is not separable ends up being separated through the power of the intellect. Abstraction is paradoxical: being a lie, it works. In contrast, it seems that truth, precisely because it is true, is somewhat inoperative. The advantage of abstractions is that they limit thought to things and relations that are clearly defined (and this can be at odds with precision). Virtually everything we talk about in science is an abstraction; a useful and powerful abstraction. The error, thus, does not lie in making them, but in taking them as concrete.

Let us say it more clearly: no abstraction, no thought. And without thought, there is no science. However, it is also true that: no concreteness, no life. We must abstract from the world in order to think about it, but we must also attend to the concrete particulars in order to live in it. So it is not possible to do science without abstraction, while at the same time it is possible to touch the concrete by means of our immediate experience. One may not be able to access the concrete "out there". That there may no direct access to the exterior is a pervasive assumption we cannot critique here — the primacy of *presentational immediacy* (Whitehead, 1929, p.174).

So, if one does ever really touch the “thing in itself”, if science must abstract in order to study the concrete, how to tell if one abstraction is better than another?

Exactitude depends on our interests, as Wittgenstein argued: “That which I defend myself is the concept of ideal exactitude, that would be given to us, so to say, a priori. At different times our ideals of exactitude are different; and none of them is ever the supreme ideal”. This is a key insight. Ortega put it plainly (Ortega y Gasset, 2015): abstractions are subordinate to our interests, intentions, desires, and values —which are always human values. Thus, in this sense, there is no possible separation between the sciences and the humanities. Actually, science is nested in the humanities, rather than the latter being a sprout of the former.

It is not only that the scale of observation creates the phenomenon: without values we could not act nor perceive. Values entail interests. What are they? There are many: to reduce a qualitative phenomenon to quantitative values in order to manipulate it, achieving replicability and control, so as to have more comfort; to understand life, to gain knowledge about what is, etc. In other words, if what science does is indisputable, what it says about what it does must be disputed (Canales, 2015). The tools that science allows engineers to produce in turn allow us to control nature in an unprecedented way. To any philosophical critique, the anti-metaphysically

inclined thinker (which always enacts a metaphysics) replies: science simply works. The rebuttal has the same spirit as Johnson's refutation of Berkeley by kicking a stone.

Science is exact, its predictions can be confirmed and it is, above all, useful. Yet, as Ortega puts it: "It turns out that physical truths, upon their theoretical qualities, had also the condition of being profitable for the vital conveniences of men. From them, men could intervene in nature and make it comfortable in their own benefit" (Ortega y Gasset, 2015, p.272; our translation). Thus, scientism can be defended by bourgeois, since "comfort is simple a subjective predilection (...) but one that does not reveal by itself any superiority of character" (ibid). Why would the criterium of utility supersede that of truth, or any other?

## 5. OUTLOOK

Our final words are not conclusions, nor does this article attempt to suggest a prescription or to propose a new theory. Our goal has been to draw attention to the bias of certain pervasive (and may we say pernicious) abstractions. Such abstractions have their common root in the ubiquitous assumption of "simple location", which is often presented as a fact and which we, following Whitehead, have put into question. This is the habit to believe that things are *simply-located* in space and time; namely, the idea that the world is made of "things" which are merely where they are. Both this worldview and its negation have major consequences when it comes to thinking about identities.

More precisely, simple location incurs in the fallacy to locate concrete particulars in definite portions of space and time. Particulars are not particles. When referred to space, simple location precludes wholeness; when referred to time, it precludes creativity. The triumph of such abstractions has prompted some of the technological development that we now enjoy. Furthermore, "The world of science has always remained perfectly satisfied with its peculiar abstractions. They work, and that is sufficient for it" (Whitehead, 1925, p.66). Yet, granting scientific engineering such achievements, one must also address their contributing to the destruction of our planet (which we will not discuss here). Moreover, the statement that "they work" takes technological progress and comfort as ultimate values —a claim as indispensable as indefensible.

Still in operation today, such scientific-philosophical frame is too narrow for current science. "It is the defect of the eighteenth century scientific scheme that it provides none of the elements which compose the immediate psychological experience of mankind. Nor does it provide any elementary trace of the organic unity of a whole, from which the organic unities of electrons protons, molecules, and living bodies can emerge. According to that scheme, there is no reason in the nature of things why portions of material should have any physical relations to each other" (Whitehead, 1925, p.73). Paradoxically, most of 21st century biology is still based on foundational ideas of 17th century physics.

Finally, a key to abandon simple location is the idea of perspective. Casting Whitehead's example: "green is not simply at A where it is being perceived, nor is it simply at B where it is perceived as located; but it is present at A with the mode of location in B. There is no particular mystery about this. You only got to look into a mirror and to see the image in it of some green leaves behind your back" (Whitehead, 1925, p.70-71). Thus, the rejection of simple location is not only the denial of self-absorbed nature of material objects in empty space, but it literally provides a different worldview from which to conceive perception. Symmetrically, the adoption of the doctrine of internal relations is the basis for a different worldview in which things are not "out there". It is not by chance that Whitehead traces the critique back to Berkeley: "It is in the search for this wider basis for scientific thought that Berkeley is so important. (...) the key of the problem lies in the notion of simple location. Berkeley, in effect, criticises this notion" (Whitehead, 1925, p.67).

Whitehead brings forward —perhaps more vigorously, but also in a more balanced way— a critique that Berkeley pioneered. The Irish philosopher questioned the existence of self-absorbed objects (and he did so much earlier than Kant talked about the “thing in itself”). Berkeley's philosophy of perception can be summarized in one sentence: To be is to perceive or be perceived (*Esse rerum est percipi*). Namely, to be is to be noticed; I perceive therefore I am. Once perception and being are equated, the world ceases to be made of things as autonomous beings.

Why should we call primary that which cannot be experienced? Once one commits to the distinction between primary and secondary qualities, conclusions are concealed in the premises. When perception is degraded in favor of measurement, experimentalists cease to be empiricists. Such strategy indeed creates an objective frame of knowledge. To say that space and time are the preconditions of experience is backwards. Experience and consciousness do not admit any mediator; they are given in immediacy. For Berkeley, the world presents to us in our perceptions, rather than being represented in them. We have been told repeatedly that our senses betray us. And that the tree would fall if nobody is looking at it. Leaving Berkeley's extremely idealist position aside, “being as perceiving” has a major advantage: it can actually dispense with *simple location*.

As Borges remarked with unrivalled genius, there is that strange habit in which some qualities are considered substantives and other adjectives (**Borges, 1925**). And yet, nature is not static like a noun or secondary like an adjective, but durational like a gerund and circumstantial like an adverb. The object-subject distinction is disorienting. It already presupposes a metaphysics of differentiated subjects with privative predicates. “We find the world's contents grouped into things and their qualities.” (**Bradley, 1893, p.19**). Bradley continues: “the thing, without the points of view, appears to have no character at all, and they, without the thing, to possess no reality— even if they could be made compatible among themselves, the one with the other. In short, this distinction, drawn between the fact and our manner of regarding it, only serves to double the original confusion. There will now be an inconsistency in our mind as well as in the thing; and, far from helping, the one will but aggravate the other” (**Bradley, 1893, p.24**). Both, matter and mind, or soul and body, are substantives “too big” for Borges.

According to Berkeley, perception is not in the subject who perceives, nor in the object perceived. It is neither in both at the same time, nor even between both. Perception is, on the contrary, what sustains them both. It is their foundation. From this worldview, the world is not made of “things”, but of perceptions. Things, perceptions, are pointers to other things. Things, being perceptions, are here and there at the same time. They are from where they look and in what they look.

Whitehead's philosophy is tilted towards the radical empiricism of Berkeley or James, in which reality is identified with experience. He attributes experience to all things in the world. Berkeley had pointed in that direction, but no one like Whitehead had brought so far the identification of experience with reality. The implications of *pan-experientialism*, and its often missed precise relation with pan-psychism (and the critiques therein) are beyond the scope of the present manuscript. If one claims that all is perception, one is quickly haunted by the doubt about who sustains the tree that nobody sees. We do not need to suppose a God that sees it and sustains it, nor to admit that the tree disappears. Those who perceive it hold the tree. The earth feels the roots, and the wind the leaves, and the nest the branch.

Whitehead coined the term “eternal object” to distance himself from the concept of essence (see Appendix). His philosophy is a critique of modern philosophy, from Descartes to Kant, which has interpreted nature and the human being through the category of substance, justifying in this way the reproach to build a solipist perspective, rather than understanding all real essences as subjects, which is the position that Whitehead adopts and that he calls the “reformed subjectivist principle”. The successful defect of the physical-mathematical scheme of the 17th century was to decide that reality is made of substances of independent existence. This

was the starting point of scientific materialism, which gave way to mechanicism. The notion of simple location is a Newtonian mirage. The classical substance is self-contained, and it cannot be “in” another substance. The real, the concrete, is a continuous process of self-identity. Entities penetrate one another. They are in themselves and in other identities.

Berkeley was discarded too precipitately. And Whitehead's philosophy is still ungrasped—if not ungraspable, by temperament or will—to many. Whiteheadian or not, our exploration of *inter*-identities beyond reductionistic and mechanistic stances (also when covert in organicism) suggests to rather conceive them as *intra*-identities. We have a fascinating challenge: to be able to think relations not between, but within.

\*

**Author Contributions.** AGM and JA conceived the project and wrote the manuscript.

**Funding.** This work was supported by the Spanish Ministry of Science, Innovation and Universities (BFU-2015-74241-JIN grant project to AGM).

**Conflict of Interest.** The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

\*

## 6. APPENDIX

It is impossible to unpack Whitehead's complex metaphysical scheme in this manuscript. However, the critique of *simple location*, the fallacy of *misplaced concreteness*, and the doctrine of *internal relations* are three fundamental elements not only to be able to re-think inter-identities as intra-identities (namely, to conceive inter-actions beyond simple location) but also to venture into his cosmology. For those profane readers willing to dive deeper into it, we have written this appendix, where we recapitulate Whitehead's more technical notes on the matter.

Stemming from the Gifford Lectures that Whitehead delivered at the University of Edinburgh in 1927 and 1928, *Process and Reality* is his *magnum opus*. It is really complicated, at least due to two related issues. First, Whitehead puts forth a metaphysics that departs from the notion of substance. He remarks that language, and to a great extent thought, follows that logic. Second, in order to present his cosmological scheme, he coins many new words, and uses existing ones with different very specific meanings. He creates a whole universe of discourse (precisely to be able to bypass “substance-thinking”). His style is a weird hybrid of imaginative poetry and hard-core mathematics.

Most cannot penetrate *Process and Reality*, and consider it obscure, if not obscene. Some are “more inclined to risk reinventing the wheel than to look for the concepts and theses we want in Whitehead's metaphysical system” (Nicholson & Dupré, 2018). Others admit that “its detractors, principally from the new analytical tradition (...) consider Whitehead's most recent work obscure, confused, woolly and mystical, not worth the effort of reading or trying to understand” and add that “some crucial passages are terse to the point of near impenetrability” or, more concretely, “The Categorical Scheme (...) is a tour de force of compressed statement, setting out Whitehead's position. It is more or less incomprehensible on a first reading, and indeed it is likely that very few readers will understand every sentence in it” (Simons, 2013). That is probably not inaccurate. The question is whether it is worthy to undergo such effort.

## 6.1. Relational essences

Let us revisit the notion of a *relational essence* by necessarily quoting Whitehead at length: “The first principle is that each eternal object is an individual which, in its own peculiar fashion, is what it is. This particular individuality is the individual essence of the object, and cannot be described otherwise than as being itself. Thus the individual essence is merely the essence considered in respect to its uniqueness. (...) Thus the metaphysical status of an eternal object is that of a possibility for an actuality. (...) Thus actualization is a selection amongst possibilities. (...) This conclusion brings us to the second metaphysical principle: An eternal object, considered as an abstract entity, cannot be divorced from its reference to other eternal objects, and from its reference to actuality generally; though it is disconnected from its actual modes of ingression into the definite actual occasions. This principle is expressed by the statement that each eternal object has a 'relational essence.' This relational essence determines how it is possible for the object to have ingression into actual occasions. In other words: If A be an eternal object, then what I is in itself involves A's status in the universe, and A cannot be divorced from this status. In the essence of A there stands a determinateness as to the relationships of A to other eternal objects, and an indeterminateness as to the relationship of A to actual occasions. Since the relationships of A to other eternal objects stand determinately in the essence of A, it follows that they are internal relations. I mean by this that these relationships are constitutive of A; for an entity which stands in internal relations has no being as an entity not in these relations. In other words, once with internal relations, always with internal relations. The internal relationships of A conjointly form its significance” (Whitehead, 1925, p159-160).

With respect to individuation, he continues: “The conception of internal relatedness involves the analysis of the event into two factors, one the underlying substantial activity of individualisation, and the other the complex of aspects—that is to say, the complex of relatedness as entering into the essence of the given event—which are unified by this individualised activity. In other words, the concept of internal relations requires the concept of substance as the activity synthesising the relationships into its emergent character. The event is what it is, by reason of the unification in itself of a multiplicity of relationships. The general scheme of these mutual relationships is an abstraction which presupposes each event as an independent entity, which it is not, and asks what remnant of these formative relationships is then left in the guide of external relationships. The scheme of relationships as thus impartially expressed becomes the scheme of a complex of events variously related as wholes to parts and as joint parts within some one whole. Even here, the internal relationship forces itself on our attention; for the part evidently is constitutive of the whole. Also an isolated event which has lost its status in any complex of events is equally excluded by the very nature of an event. So the whole is evidently constitutive of the part. Thus the internal character of the relationship really shows through this impartial scheme of abstract external relations” (Whitehead, 1925, p.123).

## 6.2. Self-transformation of essence

How to understand identity in Whitehead's terms, if we grant that things are not just where or when they are? Identity is guaranteed by the inheritance of essential features of past *actual occasions* to future *actual occasions*. In *societies* what is inherited is the *defining characteristic* (which is an *eternal object*). In other words, it is the abstract essence of processes that is inherited. But the inheritance of essence is not the main feature of living beings. Their main feature is novelty. So, in biological organisms identity is rooted in physical *prehensions*. It transforms itself but it is much more connected to specific past processes than to others. Connections between the past and the present are thus made possible by *prehensions*. Identity is built by means of a process of self-transformation of essence (or so would genuine process philosophers say). But, if an entity transforms its own essence, how can it be the same in time? How can we even talk about it? For Whitehead, an entity is not a substance but a process in the strongest sense of that word. The process of self-determination of essence is, in Whitehead's terms, an *actual occasion* that integrates through its mental pole what it has prehended and thus inherited from other actual occasions

that still exist during the new process develops itself. In Whitehead's cosmological scheme, we cease to be talking about "things" but about *actual occasions*.

### 6.3. Process and Reality

Finally, and despite all odds of not making sense, let us try to explicate and quote some key passages of *Process and Reality*, in order to seize its potential to rethink the problem of identity, as well as to make his philosophy palatable:

Three fundamental notions of Whitehead's philosophy are *creativity*, the *many* and the *one*. In his words: "The term 'one' (...) stands for the singularity of an entity. The term 'many' presupposes the term 'one' and the term 'one' presupposes the term 'many'. The term 'many' conveys the notion of 'disjunctive diversity' (...). 'Creativity' is the universal of universals characterizing ultimate matter of fact. It is that ultimate principle by which the many, which are the universe disjunctively, become the one actual occasion, which is the universe conjunctively. It lies in the nature of things that the many enter into complex unity. 'Creativity' is the principle of novelty. An actual occasion is a novel entity diverse from any entity in the 'many' which it unifies. Thus 'creativity' introduces novelty into the content of the many, which are the universe disjunctively. The 'creative advance' is the application of this ultimate principle of creativity to each novel situation which it originates" (Whitehead, 1929, p.21).

Following that paragraph, Whitehead explicitly mentions that the cornerstone of his philosophical scheme is not "substance" but *creativity*: "The ultimate metaphysical principle is the advance from disjunction to conjunction, creating a novel entity other than the entities given in disjunction. The novel entity is at once the togetherness of the 'many' which it finds, and also it is one among the disjunctive 'many' which it leaves; it is a novel entity, disjunctively among the many entities which it synthesizes. The many become one, and are increased by one. In their natures, entities are disjunctively 'many' in process of passage into conjunctive unity. This Category of the Ultimate replaces Aristotle's category of 'primary substance'". (Whitehead, 1929, p.21)

There is nothing beyond or behind *creativity*: "Thus the 'production of novel togetherness' is the ultimate notion embodied in the term 'concrecence'. These ultimate notions of 'production of novelty' and of 'concrete togetherness' are inexplicable either in terms of higher universals or in terms of the components participating in the concrecence. The analysis of the components abstracts from the concrecence. The sole appeal is to intuition" (Whitehead, 1929, p.21).

So Whitehead's is not a metaphysics of "things". For him, the world is made of *events*. In particular: "the fundamental types of entities are actual entities, and eternal objects; and that the other types of entities only express how all entities of the two fundamental types are in community with each other, in the actual world" (Whitehead, 1929, p.25).

And then we start to see a truly staunch notion of inter-identities: "to 'function' means to contribute determination to the actual entities in the nexus of some actual world. Thus the determinateness and self-identity of one entity cannot be abstracted from the community of the diverse functionings of all entities" (Whitehead, 1929, p.25). Doubly paradoxically, entities are both self-determining and internally related to other entities. "(xxi) (...) an actual entity functions in respect to its own determination. Thus an actual entity combines self-identity with self-diversity. (...) (xxii) That an actual entity by functioning in respect to itself plays diverse roles in self-formation without losing its self-identity. It is self-creative: and in its process of creation transforms its diversity of roles into one coherent role. Thus 'becoming' is the transformation of incoherence into coherence, and in each particular instance ceases with this attainment" (Whitehead, 1929, p.25).

In the following lines we may find Whitehead's deepest diagnosis on the notion of individuality: "But what Locke is explicitly concerned with is the notion of the self-identity of the one enduring physical body which lasts for years, or for seconds, or for ages. He is considering the current philosophical notion of an individualized particular substance (in the Aristotelian sense), which undergoes adventures of change, retaining its substantial form amid transition oft accidents. Throughout his Essay, he in effect retains this notion while rightly insisting on its vagueness and obscurity. The philosophy of organism agrees with Locke and Hume, that the non-individualized substantial form is nothing else than the collection of universal— or, more accurately, the one complex universal— common to the succession of 'exterior things' at successive moments respectively. In other words, an 'exterior thing' is either one 'actual entity' or is a 'society' with a 'defining characteristic' For the organic philosophy, these 'exterior things' (in the former sense) are the final concrete actualities. The individualized substance (of Locke) must be construed to be the historic route constituted by some society of fundamental 'exterior things,' stretching from the first 'thing' to the last 'thing'" (Whitehead, 1929, p.55-56).

We could go on quoting and glossing Whitehead's cumbersome cosmology, as one concept requires another, and so on (ironically, Whitehead's notions seem internally related). But we will stop here, both cautioning and encouraging the reader to dwell into other portions of Whitehead's extraordinary and extraordinarily unappreciated opera, to seek for further insights into the problem of identity.

## 7. REFERENCES

- Berkeley, G. (1710) *A Treatise Concerning the Principles of Human Knowledge*.
- Borges, J.L. (1925) *Inquisiciones*. Alianza Editorial.
- Bradley, F.H. (1893) *Appearance and Reality: A Metaphysical Essay*. London: Unwin Ltd.
- Canales, J. (2015) *The Physicist & The Philosopher*. Princeton University Press (New Jersey).
- Čapek, M. (1991) Simple Location and Fragmentation of Reality. *New Aspects of Time* 167-190.
- Descartes, R. (1644) *Principia Philosophiae*.
- Dupre, J. and Nicholson, D. (2018) *Everything Flows: Towards a Processual Philosophy of Biology*. Oxford University Press.
- Faraday, M. (1839) *Experimental Researches in Electricity* 2, 293.
- Gilbert, S.F. and Sarkar, S. (2000) Embracing complexity: organicism for the twenty-first century. *Developmental Dynamics* 219:1-9.
- Gomez-Marin, A. (2019) Evolution and what the intellect makes of it. Koutroufinis & Pikarski (eds.). *Unprecedented Evolution: Continuities and Discontinuities between Human and Animal Life, Process Century Press* (forthcoming: Preprint: <http://philsci-archive.pitt.edu/14555/>)
- Hemzell, R. (2017) *The Philosophy of Consciousness: Hegel and Sri Aurobindo*. University of Human Unity.
- Jaeger, J., and Monk, N. (2015) Everything flows: A process perspective on life. *EMBO Rep.* 16(9): 1064–1067.
- Koutroufinis, S. A. (2014) *Beyond Systems Theoretical Explanations of an Organism's*



- Becoming: A Process Philosophical Approach. In *Life and Process* (ed. Koutroufinis), p.99–132. Berlin, De Gruyter.
- Locke, J. (1689) *An Essay Concerning Human Understanding*.
- Maxwell, J.C. (1891) *A Treatise on Electricity and Magnetism*. Oxford 176-179.
- Maxwell, J.C. (1992) *Matter and Motion*. New York, Dover Books on Physics.
- Moore, G.E. (1919) External and Internal Relations. *Proceedings of the Aristotelian Society* 20:40-62.
- Nāgārjuna (2011) *Mūlamadhyamakakārikāh*. *Fundamentos de la vía media*. Translated by Juan Arnau Navarro. Siruela.
- Nicholson J.N., and Dupré J. (eds.) (2018) *Everything Flows: Towards a Processual Philosophy of Biology*. Oxford University Press.
- Ortega y Gasset, J. (2015) *¿Qué es filosofía? y otros ensayos*. Alianza Editorial, Madrid
- Panikkar, R. (1961) *Ontonomía de la Ciencia*. Gredos, Madrid.
- Rosset, C. (1976) *Le réel et son double: Essai sur l'illusion*. Gallimard.
- Santos, F. and Sia, S. (2007) The Fallacy of Simple Location and the Ontologies of Substance and Event. *Personal Identity, the Self, and Ethics*, 91-114.
- Simons, P. (2013) Alfred North Whitehead's Process and Reality. *Topoi*.
- Whitehead, A.N. (1925) *Science and the Modern World*. Cambridge University Press, 1953.
- Whitehead, A.N. (1929) *Process and Reality*. New York: The Free Press, 1978.

\*\*\*