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Physical processes, their life and their history

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ABSTRACT. Here, I lay the foundations of a high-level ontology of particulars whose structuring principles differ radically from the 'continuant' vs. 'occurrent' distinction traditionally adopted in applied ontology. These principles are derived from a new analysis of the ontology of "occurring" or "happening" entities. Firstly, my analysis integrates recent work on the ontology of *processes*, which brings them closer to *objects* in their mode of existence and persistence by assimilating them to continuant particulars. Secondly, my analysis distinguishes clearly between *processes* and *events*, in order to make the latter abstract objects of thought (alongside *propositions*). Lastly, I open my ontological inventory to *properties* and *facts*, the existence of which is commonly admitted. By giving specific roles to these primitives, the framework allows one to account for static and dynamic aspects of the physical world and for the way that subjects conceive its history: *facts* account for the life of substances (*physical objects* and *processes*), whereas *events* enable cognitive subjects to account for the life story of substances.

KEYWORDS: physical process, physical object, event, property, fact, proposition, occurrence-maker, mental and social stratum, intentional individual

1. Introduction

In current metaphysical theories, the categories *process* and *event* appear to be intimately linked. These two categories embody the dynamic nature of the world by corresponding to entities that "occur" or "happen". They contrast with *objects* and also the *matter* of which objects are constituted: *objects* and *matter* embody the stability of the world by "enduring". A firmly grounded doctrine considers the relationship between *processes* and *events* as analogous to that between *matter* and *objects*: processes are the "matter" of events, which amounts to saying that events are "constituted" by processes (Mourelatos, 1978; Galton & Mizoguchi, 2009; Crowther, 2011; Steward, 2013). According to this 'constitutive' doctrine, processes and events are concrete entities that inhabit the same spatiotemporal region of the physical world. The doctrine is not, however, written in stone; indeed, new proposals in several areas of metaphysics call it into question.

In particular, recent work on the metaphysics of processes has linked the latter to entities that temporarily bear properties and are able to change in the same way that endurants do (Stout, 1997, 2003; Galton, 2006). For example, these works postulate that a walking process exists for as long as the person is moving. Over time, the process can vary temporarily with regard to speed and direction. In short, processes are either “occurring” continuants (Stout, 2016) or conversely “continuant” occurrences, i.e. entities that extend in time, have temporal parts but also temporarily bear properties that may change (Steward, 2013, 2015). One issue (related to characterizing the nature of processes) thus concerns the ontology of time and the occupation of time (Crowther, 2011): do processes fully exist at certain instants (like three-dimensional entities) or do they only exist over extended periods of time (i.e. as four-dimensional entities)? A related issue is the need to clarify the notion of “occurrence” with regard to that of “existence”: when it is said that a walking process or a displacement “occurs”, what does this mean in terms of *existence*?

In parallel, the literature on the metaphysics of events continues to raise a number of questions - even though Davidson’s (1969) conception of events as concrete individuals continues to predominate. Soon after Davidson’s publication, a number of researchers expressed doubts about whether events (or at least those defined by Davidson) exist (Horgan, 1978; Hacker, 1982a). These events are commonly considered to be ‘complete’ occurrences, like ‘Paul’s walk this morning to the train station’. This type of event might exist but in thought only. According to Horgan, there is nothing to justify the existence of this type of spatiotemporal event. By the way, some metaphysicians (who admit the co-existence of processes and events) are tempted to consider events as abstract entities (Gill, 1993) in line with the early proposals by Chisholm (1970) and Wilson (1974). Although the existence of two distinct ontological categories - processes and events - does not appear to be in doubt (and is even considered to be useful (Steward, 2015)), the merits of the doctrine whereby events are constituted by processes (assuming that these entities are located in the same spatiotemporal region) can be questioned.

Indeed, the purpose of the present article is to present an ontological framework that is a sufficiently coherent, credible alternative to the above-mentioned ‘constitutive’ doctrine. My proposal is based as much on a new approach as it is on a conceptual framework that organizes the oppositions between ontological categories in a different manner. The ontological framework stems from Galton’s suggestion (2006, 2008) of replacing the ‘continuant’ vs. ‘occurrent’ distinction by the EXP vs. HIST distinction (Fig. 1) for the world as it unfolds and its history (Galton 2008, 323):

[...] processes differ markedly from events in their relation to change. Whereas events are fixed items of history which cannot be described as undergoing change, processes are more like ordinary objects in that they can be directly present at one time and can undergo change as time proceeds. This leads to a fundamental ontological distinction between EXP, the dynamic experiential world of objects and processes as they exist at one time, and HIST, the static historical overview populated by events that are generated by the ongoing process in EXP.

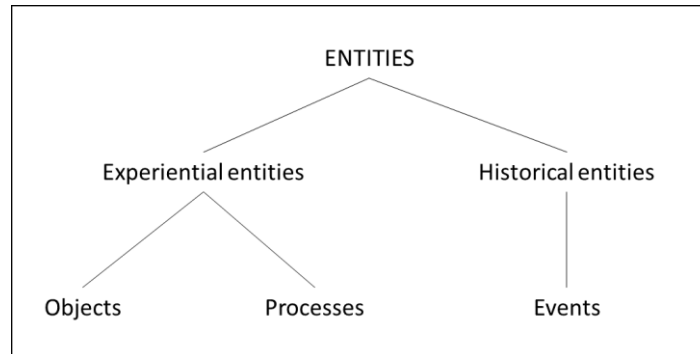


Fig 1. The distinction between experiential and historical entities (from Galton, 2008)

The present article takes up the distinction between EXP and HIST. However, whereas Galton only sees a difference in perspectives from which the world is described¹, I propose to identify “EXP vs. HIST” with a radical metaphysical distinction. My thesis is that (i) physical objects and processes exist in the world and have a life independently of how we think about them, whereas (ii) events are abstract objects of thought - constructs whose essential cognitive function for subjects is to have stories about the world. In summary, my point of view redefines the categories introduced by Galton: EXP is the physical world in motion existing regardless of being thought, while HIST is the [past, present and future] history of the world built by human subjects.

This thesis also results from a specific approach to metaphysical research. It was prompted by the questions raised by several researchers (including Galton himself) as to the contrasting modes of existence for processes vs. events – at least when the very existence of events was not questioned.

In order to define the frontier between facts and interpretations, I followed the methodological, investigative approach recommended by Ferraris (2014) (51-52):

Therefore, the point is not to claim that there is a discontinuity between facts and interpretations but rather to understand what objects are constructed and what ones are not. [...] This work consists in distinguishing carefully between the existence of things that exist only for us, that is, things that only exist if there is a humanity, and things that would exist even if humanity had never been there.

¹ Galton's words are clear in this respect (*ibid.*, 332): *The two perspectives represent two different approaches to describing the world. They are not describing different things so much as describing the same thing – the world itself – from two different points of view [...] The experiential perspective, EXP, relates to the world as we experience it, when it is present. The EXP view of the world is constantly changing; it is a world in flux [...] In contrast, the historical perspective, HIST, relates to the faits accomplis, the historical record. It is used to describe synoptic overviews that span a succession of instantaneous experiential snapshots.*

This line of inquiry prompts us to position physical processes as things that exist - even in the absence of humankind - and to position events as constructs. More specifically, I have developed the following ontological framework:

- The physical world is populated by particulars - *objects and processes*. By enduring, these particulars ensure the physical world's stability and dynamicity.
- These particulars have a life by temporarily bearing *properties* and maintaining *relationships* with other particulars. These links constitute *facts* that exist in the physical world.
- Particularly through *events*, cognitive subjects immersed in the physical world represent a (past, present and future) history of the world in order to interact with it.

In the present article, I begin by clarifying my basic ontological commitments (Section 2) and then present my ontological framework (Section 3). Given the general nature of the framework (composed of major principles for organizing the highest level of an ontology of particulars), my presentation is discursive. The axiomatization of this framework will be covered in subsequent work. I conclude the article by looking at the perspectives opened up by the present research.

2. The basic commitments

As a starting point, it should be noted that I have adopted Strawson's (1959) intention of establishing a *descriptive* metaphysics that describes "*the actual structure of our thought about the world*". This type of metaphysics assumes the existence of an ontology that underlies perception and language, and that can be explained by analyzing the categories that structure our discourses and theories. These theories commit to the existence of various common-sense or scholarly entities. A descriptive metaphysics grants the same ontological legitimacy to all these entities. In contrast, a *revisionist* metaphysics (as defined by Strawson) sets *a priori* constraints, such as preferring the ultimate reality to a common understanding and/or applying the principle of parsimony by reducing the number of ontological primitives as much as possible. Such an approach can be seen at work in Johanna Seibt's proposal of a mono-categorical ontology of processes (see, for example, Seibt, 2008). Claiming that (according to the physical sciences) material objects on the mesoscopic level (for instance, a table) are ultimately constituted on the nano level by a vortex of particles and vacuum, Seibt ontologically identifies them with dynamic masses. As stated above, my descriptive approach prohibits this identification: psychological data teach us that a wooden table is conceived by all subjects to be a solid object, regardless of the subject's knowledge about the table's ultimate composition.²

² In fact, these two types of approach are paradigmatic; any approach must borrow from one or the other. A central question that any approach must answer concerns the choice of the abstract metaphysical categories that structure the whole ontology - especially those related to *existence*: to what metaphysical theory does the ontology commit itself? Taking the example of the table,

By adopting a contemporary perspective of ontology, I consider three types of reality (physical, mental and social realities) as the main means of structuring the world. In line with my descriptive objective, these are levels of *interpretation* or *description* of a world that I further assume to be structured into three large ‘strata’ (see, for example, Roberto Poli, 2001).³ As we saw in Ferraris's quote, this three-way partition usually becomes a two-way partition when we consider human thought to be pivotal: physical entities exist independently of all human thought, whereas mental and social entities depend on humankind.⁴ According to some researchers (notably Poli), this two-way partition is justified by the similar dependences between the mental and social strata on one hand and between these strata and the physical stratum on the other (2001, 273-274): *The realm of material phenomena acts as the bearer of both mental and social phenomena. In their turn, the realms of mental and social phenomena reciprocally determine each other. The underlying idea is that there are no societies without minds, just as there are no minds without corresponding societies.* For this reason, and given the two-way partition's coherence with my purpose here, I shall solely mention two major strata hereafter (including the mental & social stratum).

Continuing on with my basic commitments, and in line with a broadly consensual conception in the field of ontology but also in the field of science, I state that the strata are themselves organized into levels (Poli, 2001). These levels are well known for the physical stratum – at least for a chain of intermediate levels: *atom-molecule-cell-organism*. By adopting a theory of *particulars* (as commonly performed in applied ontology), I consider that each level is populated by particulars whose abstract nature comes from a limited number of primitives: *object-process-quality-fact*. The links between these levels are more related to the *constitution* than to the *whole/part* relationship (with regard to this matter, see Claudio Masolo, 2010). Most physical particulars are *multilevel* in the sense that they are *constituted* by lower-level physical particulars co-located in space and time: an organism is constituted by cells, which are constituted by molecules, etc. The levels are less well identified for the mental & social stratum (Poli, 2006). My positioning of *events* in the mental & social stratum gives me an opportunity to specify some structuring principles and to clarify its relationships with the physical stratum.

As I have just pointed out, I am adopting an ontology of *particulars*, that is to say entities with a single spatiotemporal location. Particulars are usually contrasted with *universals*, which supposedly exist at two or more spatiotemporal locations. In doing

we will see that our commitments acknowledge its existence and give it a dual physical and social identity.

³ Different realistic theories have been presented in the literature. For example, Achille Varzi (a proponent of non-naive physical realism (2013)) recently portrayed a desert physical realm that gave a glimpse of a lush psychological realm (2014). For my purposes here, I do not commit to a particular theory. Nevertheless, in line with Poli (2001), I acknowledge the reality of the three strata and their commonly described levels of structure.

⁴ In the Introduction, we referred to “concrete” and “abstract” entities; these are to be understood with reference to this two-way partition.

so, we admit the objective existence of space and time. As far as time is concerned, we opt for a *presentist* theory that stipulates that only the present exists.⁵ In fact, our individuals – which are physical, but also mental and social – are to be considered as enduring entities that come to exist at a time, cease to exist at another time, and exist continuously between these times. Here, I will not seek to defend this position by comparing and contrasting it with other competing theories of time;⁶ my more modest goal is merely to demonstrate the overall coherence of my ontological framework.

When choosing my ontological primitives, one of the constraints that I set myself was the latter's generality, i.e. the primitives' value in accounting for as many levels as possible. First and foremost, this criterion qualifies the *physical object* whose presence is attested to at practically all levels - except, no doubt, at the nano level.⁷ For the *physical object*, I have adopted a characterization that is common but that I shall nevertheless discuss. A physical object is something that:

- o_i) wholly exists at instants.
- o_ii) bears properties at instants.
- o_iii) may change over time.

The properties (o_i) and (o_ii) refer to the fact that objects exist and bear properties at time *instants*. These instants correspond to temporal entities - the only ones we consider, to which we recognize an objective existence. We consider that the instants are indivisible entities that nonetheless have a duration.⁸ While enduring, objects can have incompatible properties at different instants (o_iii). According to our ontological commitments, the conception of these changes (or, in contrast, stabilities) corresponds to *events* in the mental & social stratum. We will see in Section 3.3 that descriptions of event occurrences use various subjective temporal entities, including time intervals.

⁵ It should be noted that this type of theory does not mean that one denies any form of existence to past or future entities that are not present (i.e. not actual). However, we consider that these entities are thought of by subjects as being in the past or future, which gives them a mental existence that is distinct from a physical existence or presence; this point is developed in Kassel (2019). The notion of *existence for a subject* is specified in Section 3.3 of this article.

⁶ The reader interested in a characterization of *presentism* and its position vis-à-vis other theories of time can refer to (McKinnon, 2013).

⁷ The fact that I limit myself to the physical stratum emphasizes the boundaries of my present work. I am not trying to characterize the *object* in general, nor, as we will see, the *process* in general. For the questions raised by a theory of the *object* in general in formal ontology, I refer the reader to Frédéric Nef's work (1999). Notwithstanding this limitation, a more precise characterization of the notions of *physical object* and *physical process* prompts us to distinguish them from *mental & social objects* and *processes*.

⁸ In the philosophical literature, the 'real' *instant* is commonly conceived as an indivisible of zero duration (see, for example, Dummett, 2000). However, we feel that this conception is difficult to reconcile with (i) giving time the status of an objective dimension, and (ii) accepting only temporal entities of zero duration. Moreover, we need a notion of *instant* that allows processes to exist, which means having to give them duration. Like Galton (2017), we can therefore speak of a 'dynamic present' populated by processes.

The physical object accounts for the static of the world. To account for the dynamics of the world, I introduce the *physical process*. In line with the conception that I shall give to the *physical process* (by establishing a dual relation between physical processes and objects), this primitive will benefit from the same level of generality.

3. The ontological framework

3.1. Physical processes

My characterization of physical processes is largely based on the idea of *dynamic continuants*, as developed principally by Rowland Stout (1997, 2003, 2016), Antony Galton (2006) and, to a lesser extent, Galton and Riichiro Mizoguchi (2009) and Helen Steward (2013).⁹ As a sign of the rapprochement between physical objects and physical processes, this characterization is similar to the one mentioned above just recalled for *physical objects*. A *physical process* is something that:¹⁰

- p_i) wholly exists at instants.
- p_ii) bears properties at instants.
- p_iii) may change over time.
- p_iv) is *enacted* by a physical object.

By extension, examples of *physical process* are the movement of a physical object (leading to displacement of the object or rotation of the object about itself), the growth in size of a physical body, the ripening of a fruit, the oxidation of a ferrous metallic object, and the melting of a glacier.

Let us now describe each of the properties attributed to physical processes in more detail. The first property (p_i) is expressed by Stout (1997, 26):

The phrase, ‘What is happening now’, is naturally taken to denote a whole process ; and we do want to claim that what is happening now is literally identical with what is happening at some other time – the very same process.

Before explaining the reasons for this statement, let us specify the sense in which the expression “whole process” is to be understood (Stout explained this in his (2016)). When applied to material physical objects, a common formulation of property

⁹ Let us specify at the outset that my notion of a physical process is more constrained than that promoted by these researchers. Indeed, I do not consider that ‘processes of actions’ (such as *the writing of a letter* or *the course I gave this morning*) are physical processes. The hypothetical existence of such processes is correlated with the thesis in which events are constituted by processes - a thesis that I reject. I shall return to these pseudo processes after presenting my notion of *event* in Section 3.4.

¹⁰ The identity of properties (p_i-iii) and (o_i-iii) may suggest that processes are a species of objects. In fact, it is not so. In particular, we will see that the properties carried respectively by the processes (p_ii) and the objects (o_ii) are distinct and that this distinction reflects the different metaphysical nature of these entities. Moreover, the reader can consider that the objects are characterized by the property: (o_iv) objects are not enacted by anything.

(p_i) is that objects “wholly exist at times”. I have chosen this formulation as property (o_i). According to Kit Fine (2006) (whose analysis I adopt here), this expression refers to two different notions of *existence* (in time and space, respectively). Firstly, the object *exists* fully in time; it is not a matter of “more or less” existing. One can think of the object as existing in its full *identity* (in the sense of *essence*). Secondly, given that the material object exists, it is *extended* into space; the adverb “wholly” reflects the fact that the material object occupies a whole spatial region (while partially occupying each part of the space of this region). In the case of the process, it is necessary to understand the expression “whole process” in the sense of an existence in its full *identity*, which amounts to assimilating the process to a substance that bears properties at times.¹¹

This thesis of the existence of the process in its full identity at any instant in its life, expressed by the property (p_i), corresponds to a strong commitment as to the nature of the physical processes. To clarify our commitment, we will refer to the notion of *temporal change* of a substance – the fact that a substance may bear contradictory properties (*F* and *not F*) at different times - and attribute to the process the role of causal explanation of this change.

Historically, we owe to Aristotle the first real theory of change. To do this, Aristotle has resorted to innovative conceptual tools (which will prove essential for a contemporary analysis), corresponding to a *dispositional* characterization of change over time. According to Ursula Coope (2009)’s translation and interpretation of Aristotle’s characterization in his *Physics III*:

Change is the actuality of what is potentially in some particular different state, qua such.

The ‘potentiality’ in question refers to a substance’s potential to be in a different state (hence, to be changed), whereas the ‘actuality’ corresponds to the change itself; in contemporary terms, one speaks of *capacity/disposition* and the *exercise* of a capacity/disposition. The technical nature of this definition and the interpretative difficulties to which it has given rise¹² explain why, in the 20th century, we found ourselves with a characterization of change – the *Cambridge change* – that is still

¹¹ In fact, the question of the spatiotemporal extension of the process necessarily arises. As I mentioned in the Introduction, it featured in the discussion between Steward (2015) and Stout (2016). Following Stout (2016), my approach to process characterization (i) makes the merological analysis of processes less of a priority, and (ii) highlights the notion of a dynamic continuant characterized by my properties (p_i-iv).

¹² By suggesting different definitions of the terms “potentiality” and “actuality”, contemporary commentators of Aristotle have testified to the difficulty of this interpretation. In particular, does “actuality” refer to the *transformation* of an object (in the sense of ‘actualization’) or the *updating* of a *state*? As Coope (2009) shows, the Aristotelian analysis encompasses all the current difficulties in the distinction between continuants and occurrences. In this respect, it should be noted that Aristotle’s definition of change is (according to David Charles (2015)) a ‘continuant process’ rather than an ‘occurrent event’.

subject to debate.¹³ If this conception is applied to motion as a change in spatial location, then *motion consists merely in the occupation of different places at different times* (Russell, 1903). As many philosophers have pointed out, this conception of change over time only amounts to the juxtaposition of immobilities, and does not account for the dynamic character of continuous motion - a view found expressed by Stout (2003):¹⁴

[The] motion should not be understood in Russell's way as the arrow being in one state and then in another and in the meantime being in all the intervening states. The arrow's motion is what gets it through this continuous series of states - it effects the transition.

To define the notion of the “real” arrow’s motion to which Stout refers, I rely on Carol Cleland's (1990) analysis in which Aristotle's dispositional analysis is refined by subjecting it to contemporary physical theories. To account for the dynamics of continuous motion, Cleland proposes to rely on the notion of *endeavouring* (a notion at the heart of Newtonian physics), which she names “operative tendency” (*ibid.*, 266):

In order to distinguish the sort of tendency which seems to be involved in “endeavouring” from the passive tendencies (or latent capacities) ordinarily associated with dispositional properties, I will frequently refer to “endeavourings” as “operative tendencies”.

According to Cleland, the existence of an operative tendency is precisely what distinguishes the fact (for an object) of *dynamically* passing through states, rather than being *statically* in different states. However, the existence of an operative tendency (which she also refers to as a “causal process of transformation”) does not mean that it is followed by one or more effects. For example, the existence of an “operative tendency to change places” is not enough to create such a change when the said tendency is hindered by the concomitant existence of other tendencies (*ibid.*, 273):

Indeed the failure of some of these tendencies to terminate in the changes towards which they are directed can readily be explained in terms of their lawful interactions with other tendencies; in the case of the globe, the outward centrifugal force is said to be exactly balanced by the inward centripetal force.

The example of the globe mentioned by Cleland corresponds to an experiment that anyone can perform by rotating a globe (or any other object) attached to a string around him/herself. According to Cleland, the fact that one can feel the tension in the string - in other words, the fact that the object’s tendency to be ejected is a measurable observable - constitutes a decisive argument for its physical existence (*ibid.*, 273):

¹³ The term “Cambridge change” was proposed by Peter Geach (1968, 13) to denote a conception of continuous change promoted by Cambridge philosophers including John McTaggart and Bertrand Russell.

¹⁴ For critical analyses of the “Cambridge change”, I refer the reader to (Cleland, 1990; Coope, 2009; Galton, 2017). The latter publication contains many historical references.

Given their crucial role in physical explanation and theory, I propose that we admit operative tendencies to be elsewhere into our ontology as primitive properties of physical objects. We can think of them as physicists think of instantaneous vector quantities, viz., as uneliminable proclivities of varying degrees of strength.

In summary, by opening our inventory to these 'operative trends' or 'property transformation processes', we become able to ontologically distinguish between mere "Cambridge changes" and "real changes". A "Cambridge change" is a temporal series of facts corresponding (for an object) to successive possessions of distinct properties. A "real change" is a "Cambridge change" resulting from a property transformation process, where the term "resulting" means that there are effects on the object. For completeness' sake, let us note that conversely, processes can exist without producing change when their effects are thwarted by those of other processes. This type of ontological commitment ultimately leads us to distinguishing the *process of change* from the *change* itself.

By way of an illustration, consider an object exerting pressure on another object: my hand pushing on a door, for example. As long as the door resists my force, the door does not move. Yet, two processes with opposite effects exist.¹⁵ Let us assume that I push harder, and cause the door to judder. I consider that this impact corresponds to the birth of a new process – the process in which the door moves about its hinges – in addition to the two processes already present (my pushing on the door, and its resistance) and which continue to exist. This process of movement leads to the door's opening.

The analysis of this example shows us that although the distinction between process and change is scientifically grounded (to account for the dynamics of physical bodies), it is also relevant for analyzing human behaviors, in any case human body behaviors. It should be noted that when analyzing human movements, we use concepts that selectively denote processes and movements. On one hand, 'to push', 'to pull', but also 'to walk' and 'to run' can be considered as denoting processes, in the sense of exercising a force or performing an activity that requires effort. On the other hand, 'to move', 'to cross', 'to climb' and 'to jump' can be considered as denoting movements, in the sense of changes in spatial location.

This characterization makes it possible for a process to bear properties that can vary in time (i.e. properties (p_ii) and (p_iii)). According to Galton (2006, 6), this characteristic makes processes more similar to objects:

Like objects, processes can change: the walking can get faster, or change direction, or become limping. All around us processes undergo changes: the rattling in the car becomes louder, or changes rhythm, or may stop, only to start again later. The flow of the river becomes turbulent; the wind veers to the north-west.

¹⁵ By limiting our inventory to two processes, we preclude the existence of other processes - especially those whose effects keep the door on its hinges.

What Galton expresses here fits in perfectly with my conception of a process. The examples considered are those of processes manifested by observable effects. These effects correspond to ways of being distinct from those of objects (Hacker, 1982b): although a process has no color, mass or volume, it is characterized by speed, direction, sonority, and amplitude. Furthermore, and given that processes temporarily bear properties, the latter can vary; this corresponds to a process that changes. Consequently, I consider that an acceleration or a variation in speed is a process' change (p_iii).

In the literature, by contrast, some researchers (*e.g.*, Smith, 2012; Crowther, 2018) consider that a process cannot change. They consider that when a person starts to walk more quickly, this is a change for a person possessing different walking speed properties at distinct instants, rather than a change over time in a “walking” process. According to Smith and Crowther, a process is itself a change and thus cannot change *per se*. In the Basic Formal Ontology (BFO, Smith, 2012), processes are classified as 'occurrences', i.e. as four-dimensional entities that do not possess qualities. Speed is therefore considered to be a quality of a moving object.

Basically, the idea that a process can change is supported by (i) the thesis in which the process exists at every instant (p_i) and (ii) the definition of the nature of the process that we have just adopted. Another notable argument in favor of this idea is the fact that we can change processes by acting on them. Thus, we can act on the ripening process of a fruit to slow down or accelerate it, just as we can act on our walking process to slow it down or speed it up. Moreover, it should be noted that in a situation where the same object operates several processes, the latter can be modified selectively. If, for example, we make a hand gesture while walking, we can selectively adjust the speed of these each process. Therefore, we consider that attributing these speeds to processes rather than to objects is a better option in both conceptual and ontological terms.

To complete my characterization of physical processes, let me now mention an additional ontological commitment: a process is anchored within a *support object*, rather than being a continuant that floats in the air. The process is one in which *an arrow* moves, a *fruit* ripens, a *glacier* melts, *etc.* To account for this strong constitutive link, I adopt the *enactment* relationship introduced by Galton and Mizoguchi (2009) by adapting it to my conception of the process.

According to the latter researchers, saying that an object “enacts” a process amounts to saying that an object carries an “external” process or exhibits a “behavior” (*ibid.*, 94):

The key notion is that an object, considered from a particular point of view, is characterized in terms of the processes it enacts. These are what we call the external processes or behavior of the object. This behavior arises as a result of various internal processes which causally contribute to it.

This characterization of Galton and Mizoguchi's enactment relationship relies on the conception of an object as an interface between *internal* and *external* processes; the former contributes causally to the latter. Basically, the characterization says that

external behaviors are causally determined by internal processes. This idea agrees with our notion of process causing change, although we do not identify change as an external process. We propose a different division of reality, prompting us to modify this enactment relationship.

We postulate that the enactment of process by an object corresponds to a 'real' change of the object; in other words, the enactment corresponds to a situation in which the process produces its effects by causing a change. Thus, '*O* enacts *P*' means that the process *P* within the object *O* produces a change in the object *O*. The causal relationship now links a process and a change (an entity that we will define in Section 3.3), rather than two processes.

The reader may point out that by using the opposite relationship – *P* is enacted by *O* – in the property (p_iv), we limit the property to processes that manifest their effects. This is indeed true, although we wish to point out that the elements of language used to designate processes (such as *walking*, *running*, *dilating*, etc.) necessarily designate processes that manifest their effects. The reason is simple: the processes' perceptible manifestations contribute to their identity criteria. This remark prompts us to consider that a situation of 'real' change (*e.g.*, as described by the phrase '*Paul is walking*') is equivalent to a process enactment fact: Paul *enacts* Walk_{#i}, Walk_{#i} being a particular walking process.

Although we amend the enactment relationship, we maintain Galton & Mizoguchi's opinion whereby processes depend existentially on other processes within the object: A person's walking process is only possible if physiological processes enacted by the person's organs exist concomitantly. In turn, these are only possible if processes enacted by tissues, cells and molecules exist concomitantly. This conception highlights a double hierarchy of constitution relations (and thus of existential dependences) between processes and objects situated at different levels of the physical stratum.¹⁶

This conception of the relation between *processes* and *objects* means that to account for physical reality, these two primitives have to be positioned on the same level (in terms of priority). This conception is *de facto* out of step with the process-based metaphysics that prioritize the process relative to the object, arguing that material objects "*are ultimately comprised of energy that is in an ongoing state of flux and motion*" (Rescher 1996, 28).¹⁷ As I pointed out in Section 2, I am seeking to establish a descriptive ontology of the world. Therefore, I consider that our scientific knowledge of the ultimate constitution of physical objects (for example, the mesoscopic artifacts surrounding us) does not interfere with common-sense concepts about these objects: a table remains a solid physical object. The property (p_iv) is also at odds with a second common thesis in process metaphysics, according to which

¹⁶ In his work in (2000), Peter Simons defends a thesis concerning the endurance of physical objects by highlighting this same dual hierarchy of constitution relations between objects and 'occurrences', with the latter corresponding to my processes.

¹⁷ For a general overview of the 'process philosophy', the reader can refer to (Seibt, 2018).

certain processes described as “unowned” have no physical support (i.e. are not enacted by any object), as expressed by Nicolas Rescher (*ibid.*, 42):

The distinction between ‘owned’ and ‘unowned’ processes also plays an important role in process philosophy. Owned processes are those that represent the activity of agents: the chirping of birds, the flowering of a bush, the rotting of a fallen tree. Such processes are ownership attributable with respect to “substantial” items. Unowned processes, by contrast, are free floating, as it were, and do not represent the activity of actual (i.e., more than nominal) agents: the cooling of the temperature, the change in climate, the flashing of lightning, the fluctuation of a magnetic field.

At this stage in my characterization of objects and processes, nothing allows me to accredit the existence of these ‘unowned’ processes. My descriptive approach prompts us to admit the existence of processes like the warming of a lake, or global warming. Simply, these processes’ support entities are objects from the physical stratum that exceed the mesoscopic scale and can attain the “macro” or even “astro” scale. Moreover, it should be noted that in formal ontology, characterization of physical objects tends to deal with solid material objects. In contrast, the ontology of entities like a river, a wave, a fire or a magnetic field has yet to be greatly clarified. With property (p_iv), I hypothesize that advances in the ontology of these entities will enable us to elucidate processes enacted by these entities.

In summary, I have chosen Cleland’s conception of ‘causal process of transformation’ for physical processes (1990), and have intensionally characterized this primitive with properties (p_i-iv). By extension, further examples can be added to those mentioned at the start of this section; these processes correspond to a human activity, and have effects on the human body (e.g., ‘walking’, ‘running’, and ‘smiling’) or on its environment (e.g., ‘writing’, ‘shouting’, ‘pushing’, and ‘pulling’). It should be noted that all these processes are designated by linguistic terms, which shows that these processes are thought about and talked about. Hence, Cleland’s justification of the existence of processes by resorting to the physical sciences is supplemented by another argument – linguistic this time – for these processes’ place in a descriptive ontology.

3.2. The life of processes

At this stage, my ontological inventory is composed of substances (i.e. physical objects and processes).¹⁸ Given that these entities persist in time and maintain their identity, they exist at different instants; this prompts us to talk about their “life”. Intuitively, the term “life” denotes what happens contingently to a substance between the moment when it comes into existence and the moment when it ceases to exist. On the human time scale, some substances have a short life. This is the case for

¹⁸ To be more precise, I have characterized objects and processes as *substrates* bearing properties rather than as *substances*, since the latter notion usually assumes existential independence. In fact, the position of the author is to deny the existential independence of both objects and processes. However, this point will not be addressed in the article and I shall continue to use the term “substance” in the sense of “substrate”.

elementary particles studied in the field of high-energy physics; a particle's lifespan (like that of its movements) is only a tiny fraction of a second. Other substances (such as stars, galaxies, and their movements) have a long or even seemingly eternal life on the human scale. The properties (o_ii) and (p_ii) characterize the building brick of an object's life and a process's life, respectively. It should be noted that they assume the existence of objects and processes' *properties*. To give these bricks a place in my inventory, I will provide some details about their nature. Moreover, the brick itself expresses a *tensed fact*. Following a now well-established metaphysical conception, I also add the *tensed fact* primitive to my inventory. In summary, what I call a substance's "life" corresponds to an accumulation of facts throughout the substance's existence.¹⁹ The property (p_iv) reflects the existence of a very close relationship between the life of processes and that of objects. In this section, I shall flesh out my characterization of a process's life by adding particular facts in which one process *perpetuates* another. This prompts us to better characterize the dynamics of the world by rendering them accountable through facts involving processes - a role that the metaphysics of 'occurrent' entities traditionally devolves to events.

Let us start with *properties*, and with both terminological and ontological clarification. The term "property" is commonly used to denote *universals* (or *types*) and *tropes* (or *instances*) objectively characterizing substances (Armstrong, 1989) on one hand, and *concepts* or *categories* that structure our representations and theories of the world on the other (Margolis & Laurence, 1999). On an ontological level, this amounts to admitting the existence of two categories of properties, respectively concrete and abstract, possessing different modes of existence and to which also different modes of attribution (predication) correspond. As I will show later, the coherence of my ontological framework requires us to consider both. For the notion of life described in this section, we will see in particular that it is relevant to distinguish between a substance's "physical" life and its "social" life. To distinguish between the two, I will refer to them as a "physical property" and a "social property", respectively.

Thus, we can firstly identify physical properties whose existence is independent of human thought (these properties are covered in detail by Armstrong (1997, chapters 2 & 3)).²⁰ As mentioned above (and in line with Peter Hacker (1982b)), I consider that

¹⁹ The term is taken here in a technical sense, which should be distinguished from the notion of *life* to which we commonly refer when we speak of (for example) Paul's life. As we will see in Section 3.3, this second notion conceptually assumes that a bounded spatiotemporal region is being considered. On the ontological level, I do not propose a primitive that accounts for an open, indefinite set of facts. On the other hand, I consider that Paul's life is an *event*.

²⁰ Different theories have been proposed to account for the nature of these properties. For some theorists (notably Armstrong), properties are universals, i.e. entities that repeat themselves identically in substances. Other theorists consider that properties are tropes, i.e. particulars inherent to their bearer. Here, I have chosen not to take sides. It should be noted that hybrid conceptions (combining universals and tropes) have been suggested in the literature. In applied ontology, properties that are subject to perceptual experience by subjects (*e.g.*, color, shape, and speed) are often conceived as tropes. This type of treatment is found in the BFO (Grenon & Smith, 2004) and the DOLCE ontology (Masolo *et al.*, 2003).

objects and processes bear different physical properties. A physical object's way of being (that of a person, for example) corresponds to properties/relations such as 'Being anxious', 'Being beside Mary', and 'Walking'.²¹ For a process, examples of properties are 'Being fast', 'Being noisy', and 'Slowing down'. Secondly, I identify social properties whose existence depends only on human thought (Searle, 2010). Typically, these properties correspond to functions that one attributes to physical objects (e.g., 'Being a table' or 'Being a paperweight') or to physical processes (e.g., 'Being an endorsement' or 'Being a threat').²² We shall now see that this distinction of modes of existence among properties is reflected by distinct modes of existence among facts.

After having introduced the category of property, I continue by expanding my inventory to *facts*. The thesis in which these entities exist (advanced by many philosophers, e.g., Kit Fine, 1982; David Armstrong, 1997) accompanies the real theory (i.e. a theory of "physical" existence) of properties. The simultaneous existence at a given instant of the substance 'Paul' and the property 'Being anxious' does not mean that the substance 'Paul' exemplifies the property 'Being anxious' at this instant. The same holds for the substance 'Paul' and the relationship 'Being beside Mary'. The fact (a "state of affairs", according to Armstrong's terminology, or a "circumstance", to use Fine's term) corresponds to the internal link that unites (at a given instant) the substance and the property/relation to create an entity in its own right.²³ The main

²¹ As we saw in Section 3.1, this last property is in fact a relational property - that of enacting a particular walking process.

²² The processes in question may respectively be 'a movement of the head' and 'a movement of the fist'. According to Amie Thomasson (2003), we assimilate artefactual objects and processes (or at least functional objects and processes) to 'concrete social' entities, i.e. physical entities on which social intervenes. The difficulty in performing an ontological analysis of these entities lies in the fact that they are located at the interface between the physical stratum and the mental & social stratum (see, for example, Kassel, 2010). In any case, these concrete entities differ from abstract entities, which include abstract objects (e.g., currencies, laws, and nations) and abstract processes. Although I do not deal with abstract entities in the present article, one can distinguish changes in social properties for concrete social objects (e.g., 'a person becoming a widower' or 'a bank note losing its face value') or for abstract social objects (e.g. 'the depreciation of a currency' or 'a law falling into disuse').

²³ Let us take advantage of these terminological remarks to point out another similar notion: that of Jaegwon Kim's "event" (1976). According to Kim's theory of "exemplification of a property by a substance", an event (e.g., $\langle \text{Paul}, \text{Falling}, T \rangle$) exists when a substance x instantiates a property P at a time t . However, not every property P can constitute an event: for a substance, Kim proposes keeping only properties that correspond to ways of changing or transforming (and, further still, "really" changing or transforming). Thus, in order to embrace events ordinarily thought of as changes, the constituent properties selected by Kim for his events encapsulate a causality (e.g., 'Falling', 'Walking' or 'Freezing'). Note that these refer to my processes. Furthermore, we can match them with either process enactment facts (e.g., $\langle \text{Paul}, \text{Enacting Fall}_{\#i}, I \rangle$ - $\text{Fall}_{\#i}$ being an instance of the Fall type) or facts related to the life of the process (e.g., $\langle \text{Fall}_{\#i}, \text{Being fast}, I \rangle$). If we consider that a *way of changing* is a *way of being*, we can conclude that Kimian events are equivalent to Armstrongian facts. In fact, Kimian events do not make it possible to account for an important category of phenomena usually considered to be events, namely changes in the state of substances (e.g., 'Paul became white like a sheet', or 'Paul lost his balance'). Intuitively, this type of change presupposes the existence

argument for the existence of facts is that they constitute truth-makers, i.e. that which makes propositions like 'Paul is anxious' or 'Paul is beside Mary' true in the world (Armstrong, 1997). The reader will have noted that I have admitted time as a constituent of my facts; I thus consider tensed facts. This is consistent with the properties (o/p_ii), which assert that objects and processes bear properties at instants. However, this choice has an impact on the facts' mode of existence. Indeed, facts only exist at times at which (a) their constituents exist, and (b) their constituents are bound by the relation expressed in the fact; hence, facts only exist at the instant corresponding to their temporal constituent (e.g., at the instant *I* for the fact $\langle \text{Paul, Being beside Mary, } I \rangle$). These are states of affairs that 'obtain' (or 'are actual') at this instant: they do not endure in time.²⁴

In line with my distinction between physical and conceptual properties, I distinguish between 'physical' facts (or 'brute' facts, to use Searle's terminology) and 'social' facts. Physical facts are independent of all human thought towards them: the fact that 'Paul is next to Mary at this instant' has a physical reality, independently of what Paul or Mary or any observer might think. In contrast, social facts are human constructs; for social facts, the association of a property with a substance corresponds to a human stipulation. In his description of the construction of social reality, Searle (1995) gives us some examples. To summarize his analysis and his 'account for' relationship (used to denote the result of this stipulation), a piece of paper *counts as* 'Being a 10 euro banknote' (for an agent or a community of agents, under certain circumstances), and a pebble *counts as* 'Being a paperweight'. The analysis is also valid for facts involving processes: a movement of lips *counts as* a smile; an elevation of the arm *counts as* an indication to turn left. The literature contains various analyses of social facts (see, notably, Thomasson, 2003). Searle's analysis is cited here as an example. Most importantly, I wish to emphasize that the life of a substance is not limited to its physical life but that it also involves (for cognitive subjects) a social life.

Returning to physical facts and in order to complete their characterization, let us specify their conditions of identity. Armstrong and Fine suggested two types of condition. According to Armstrong (1997), the criterion is *structural: It is a necessary condition for their identity that they contain exactly the same constituents, exactly the same particulars, properties and relations (ibid., 131-132)*. Furthermore, the organization within the structure also counts: *We add that besides containing the very same constituents, identical states of affairs must have their constituents organized in just the same way (ibid., 132)*. According to Fine (1982), who admits this structural criterion, the criterion may be *secondarily empirical: Two facts will be identical when they necessarily co-exist, i.e. when it is necessary that the one exist just in case the other does (ibid., 58)*. One obstacle to adopting one criterion or another is the admission that two structurally distinct facts - such as $\langle \text{Paul, Being beside, Mary} \rangle$

of at least two Kimian events accounting for Paul's distinct states. These changes are part of the life story of substances that I shall discuss in the next section.

²⁴ We mean that if an object bears the same property at different times (e.g., $\langle \text{Paul, Being beside Mary, } I_1 \rangle$, $\langle \text{Paul, Being beside Mary, } I_2 \rangle$, etc.) this situation corresponds in the world with as many facts existing only at the instant of their temporal constituent (i.e., *I*₁, *I*₂, etc.).

and $\langle \text{Mary, Being beside, Paul} \rangle$ (borrowing Armstrong's notation for relations) - may empirically be considered to be identical. Armstrong finally admits this: *Allegedly different facts or states of affairs that respect this condition will supervene on each other, and so according to the usual argument will be nothing more than each other* (*ibid.*, 133-134). So, I shall stop there for physical facts.²⁵

Before ending this section on facts, and in view of the forthcoming discussion on the notions of *occurrence* and *event*, let us consider two categories of brute facts related to the dynamics of the world. I have already mentioned the first category, where property (p_iv) indicates that every process is enacted at every instant by an object. These process enaction facts participate in the object's 'processual life'. The second category of facts more specifically concerns the life of a process; processes can perpetuate each other through the propagation of causation. In this respect, I have adopted a relation identified by Galton (2012) in his inventory of causal-like relations between processes and events. For example, a moving mass of air can 'perpetuate' the movement of a leaf, and the movement of a person's arm can 'perpetuate' the movement of his/her wristwatch. By participating in the dynamics of the world, the enactments and perpetuations of processes can be said to 'happen'. Ontologically speaking, I identify them with *complex* facts corresponding to the conjunction of elementary facts. It is important to note that these *complex* facts are still facts that obtain at instants.

In summary, this section set out my technical notion of the life of continuants, in order to define the "life story" concept for processes (the subject of the following section). The physical life of an object can be likened to a series of temporal facts - a Cambridge change, in other words. Depending on the property considered, we therefore have many Cambridge changes. My choice of the notion of an instantaneous, tensed fact does not make it possible to account for the existence of series of temporal facts. However, it does make it possible to account for the facts that compose these series. A process's physical life can also be likened to a series of tensed facts, such as a series of velocity facts or a series of sonority facts. Moreover, with regard to processes perpetuation facts, we have seen that part of the life of processes corresponds to a series of instantaneous, complex facts. It should be noted that these facts are not usually included in inventories of occurrences, since they are neither *processes*, *events*, *states* nor *changes of state*. In any case, the role of instantaneous, complex facts in explaining the dynamics of the world is an additional argument in favor of their existence, and completes the truth-maker argument.

3.3. *The life story of processes*

Let us now consider a human construct, namely the way humans conceptualize the life story of the substances – the physical processes and objects – that populate the world. The main ontological category that I shall add to my inventory is that of an

²⁵ For the purposes of the present article, I do not wish to discuss the conditions of identity for social facts. This would take us too far, and beyond the commitments I wish to make for the nature of properties.

event. As mentioned in the Introduction, several works published in the early 1970s (Roderick Chisholm, 1970; Neil Wilson, 1974) suggested taking events out of the physical stratum and bringing them closer to *propositions*. At that time, however, the ontology of entities proposed by philosophers in connection with thought and language (*facts*, *states of affairs*, *events* and *propositions*) was in its infancy.²⁶ Since then, advances have been made, justifying the existence of these entities and specifying their semantic role. We have just seen that the *facts* (in the Armstrongian sense) are situated on the side of *reference* by playing the role of truth maker. The *propositions*, which recent conceptions identify with cognitive entities (Soames, 2014), are on the side of *meaning*, playing the role of the truth bearer. In this section, pursuing our logic of accounting for the history of the life of substances, we will propose a conception of the *event* as an abstract entity close to the propositions and whose main property is to be able to occur²⁷.

I consider that an event is an entity that falls within the mental & social stratum, and:

- (e_i) exists for a given subject at instants.
- (e_ii) may *occur*.
- (e_iii) cannot be repeated.
- (e_iv) bears properties at times.
- (e_v) may change over time.

Before discussing these properties, let us take care to characterize in extension the class of events. The diversity of events is due to the number of substances involved and to the life period taken into account for these substances.

Basically, conceiving the life story of substances in isolation amounts to considering an episode in their life - in other words, a slice of life limited in time. This mechanism has been described by Galton and Mizoguchi, with the aim of (i) distinguishing between *processes* and *events*, and (ii) abstracting this distinction from the question of duration (2009, 75):²⁸

We maintain, on the contrary, that so far from being a mark of short duration, boundedness is a precondition for the assignment of any definite duration: processes endure, but only once we have assigned bounds to them can we speak

²⁶ For example, Kim (whose events I have likened to concrete Armstrongian facts) states cautiously (1976, 177): *I shall not discuss here Roderick M. Chisholm's very different theory of events as 'states of affairs' in his sense of abstract intensional entities.*

²⁷ In this respect, we will compare our events with thought states of affairs that obtain or not (Textor, 2016).

²⁸ It should be noted that, while I give credit to this cognitive process of abstraction, on the other hand, unlike these researchers, I do not espouse the thesis of concrete events nor the thesis of the constitution of events by processes.

of duration, and the act of assigning bounds means that we have switched our attention from the process to an event.

For a running process, a slice of life could be 'the first 10 seconds of Paul's run'. For a person, a slice of life could be 'Paul's childhood' (although there are many slices of life for people: adolescence, youth, retirement, old age, etc.).

Returning to the life story of a particular substance, another category of events concerns changes over time in one aspect of a substance. States reflect stability over time, for example: 'Paul's tiredness this morning' (for an object); 'The slow walking speed during the first 5 minutes of Paul's walk' (for a process). Changes, on the other hand, reflect a modification in a substance's aspect, for example: 'Paul's journey to the station this morning' (for an object); 'Paul's lightning-fast acceleration in the last 100 meters' (for a process). It should be noted that I consider *states* and *changes* to be two types of event, as can be seen in the literature on psychological event models²⁹.

Lastly, and again by extension, events concern the lives of a large number of objects and processes, by example: 'the fight that broke out in front of me this morning', 'the party organized for Paul's birthday today'. Some events, such as 'the assassination of Caesar on March 15, 44 BC' or 'the sinking of the Titanic on April 14 and 15, 1912', have a social dimension. Others have a more private dimension, like 'my last bike accident'.³⁰ As these examples show, some events are intentional, and others not. I have argued (Kassel, 2018) that the actions we plan and (sometimes) realize are an important class of events. These include individual actions (*e.g.*, 'my writing of this article') and collective actions (*e.g.*, 'the FOIS 2018 conference').

Let us now turn to the intensional characterization of events, and first of all the thesis (e_i) according to which events populate the mental & social stratum. Two questions can be posed. Firstly, do all events belong to the mental & social stratum,

²⁹ This position of considering states and changes as being of the same nature may surprise the reader; traditionally, one distinguishes between states and events, with the latter being identified with state changes (and states must exist if we are to speak about changes). We justify this position by considering that our states and changes are *representations* of the changes in the life of substances, rather than brute facts directly constituted by concrete substances. Moreover, state (or stability) and change are two types of evolution. This viewpoint is adopted in Warglien *et al.*'s cognitive model of events (2012). Warglien *et al.* hypothesis assimilates state and change with stability or change in representations in a conceptual space, respectively (*ibid.*, 161-162): *For example, as an apple ripens, its representation moves from green to red in colour space and from sour to sweet in taste space. Thus the representation of the object changes from one position (the start point) to another (the end point) within the underlying conceptual space.* Therefore, according to Warglien *et al.*'s model, a change in this space corresponds to a vector of points, whereas a state is identified with a single point (an identity vector). In this model, states and changes therefore have the same nature.

³⁰ The private *vs.* social distinction we are discussing here corresponds to the mental *vs.* social distinction, in other words to the subjective *vs.* intersubjective character of the events.

i.e. can we say that there are no (Davidsonian) concrete events? And secondly, what does 'existing for a subject' mean for an event?

In order to deal with the first (negative) question, I shall first consider the example of a simple phenomenon (a person falling over involuntarily – *Paul's fall*) that occurs in a given place and time. As we have seen in Section 3.2, an ontological inventory centered on Paul's body³¹ leads to the identification (besides Paul and a falling process) of a series of physical facts corresponding to Paul's life: *Paul enacts at the instant i a falling process* (where *i* is an instant that is part of the fall process's life period).

One of my ontological commitments is that the inventory (NB: that centered on Paul) is "complete". By this, I mean that in the absence of people observing or conceptualizing the phenomenon (assuming that the fall was so sudden that Paul found himself on the ground without having had time to think about it), no entity of a category other than those identified so far (and which one could qualify as "event") exists. This commitment is tantamount to turning one's back on the "constitution" thesis in which the process can constitute another concrete, spatiotemporal particular – namely an "event". An argument in favor of this commitment is a task that was carried out by Terence Horgan (and he alone, to the best of my knowledge) in his article (1978) *The Case Against Events*. Horgan's thesis is precisely that we do not 'need' to consider concrete events (à la Davidson), given their usual roles in theories of causality, action or scientific explanation. The problems with this argument (which requires great intellectual efforts, since it requires us to embrace all these different theories) are that it (i) relates to an (exhaustive?) set of roles, and (ii) depends on a given ontological framework. However, we have seen that the ontological framework of states of affairs has changed significantly since the late 1970s. For the purposes of the present article, I will simply invoke Occam's razor by noting that for the analysis of physical phenomena (such as the one given above), the absence of concrete events does not have an impact.³²

To address the positive question (2), that is what it means for an event positioned in the mental & social stratum to exist for a subject, it is instructive in the first place to consider the limitations of the approaches proposed to date. The state of the art has not changed greatly since Jonathan Bennett's analysis in his 1996 work *What Events Are*. When considering the same phenomenon (a physical object's fall), Bennett gives the following account of the nature of the events. A particular event (*Paul's fall*, transposing Paul to Bennett's example of a sparrow) that takes place corresponds ontologically to an instance of the *Fall* property. Bennett formulates this answer after having methodically dismissed other possibilities: a *fact*, a *temporal part of the physical object* extending from the beginning to the end of the fall, and the (easily dismissed) *physical object* itself. Although this intuitive answer makes sense, it poses

³¹ I shall leave aside the fall of Paul's organs and other material objects that make up Paul's body or that Paul could carry.

³² Concerning the analysis of agency phenomena, I recently proposed (Kassel, 2018) an ontology of action based on the Causal Theory of Action that does not appeal to concrete events. This is a first step towards a stronger argumentation.

a technical problem: given that an instance of property (or a trope) is not a substance, it cannot bear properties, and it is therefore impossible to consider that Paul's fall was slow at one point in time and fast at another. Here, we measure Stout's contribution in his (1997) and (2003), i.e. the substantiation of Paul's fall with his notion of process, making it possible to account for the life of this process. However, if we want to talk about the duration of Paul's fall or the fall's unexpectedness, we need an entity that is distinct from this process. As we shall see below, my choice will stand out from the trope option.

Let us now extend this example by introducing a person who observes Paul falling and then observes Paul on the ground: Mary witnesses what she considers to be (and conceptualizes as) *Paul's fall*. More exactly, I hypothesize that besides having conceptualized Paul as a person and his downward movement as a falling process enacted by Paul's body, Mary thinks she has witnessed the *Paul's fall* event that starts as soon as Paul begins to fall and ends when Paul finds himself on the ground. I therefore consider that because of the presence of Mary, my ontological inventory is enriched simultaneously by two entities: an *event (Paul's fall)* and a fact about the event (namely the event's *occurrence* at that instant).

Conceptually, the event is to be considered as a slice of life of the process of *Paul's falling*, in relation to a given temporal region (see the mechanism described by Galton and Mizoguchi, as mentioned above). Ontologically, the event is something thought by Mary and which is targeted towards the world. I therefore propose identifying this thing as an *abstract individual* or *object* in the mental & social stratum. My use of the term "individual" implies that we are considering singular events, i.e. instances of types of events. Historically, these abstract individuals can be likened to not only Hector-Neri Castañeda (1974)'s *individuals* (in his "epistemological" ontology) but also to Chisholm (1974)'s *intensional entities* (in his "intensional ontology") and Edward Zalta (1983)'s *abstract individuals*. It should also be borne in mind that I mentioned a rapprochement between *events* and *propositions*. A detour through recent works on the ontology of propositions will help us to clarify my notion of an event.

Ever since Frege and Russell's work, the *structured* proposition with constituents has been a solidly rooted conception (for a review, see Jeffer King (2017)). Among the many works having developed this conception, we note in particular those of Scott Soames (2014) and Peter Hanks (2017). These researchers share the objective of naturalizing the propositions by identifying them with representational acts carried out by subjects. In this case, these researchers moved the propositions out of a third Platonic realm outside mind and matter, and made them cognitive entities within the mental & social stratum. However, by identifying the propositions with acts (types of acts, for Hanks), these authors move away from a conception of the proposition as content. Moreover, Soames and Hanks stick to theorizing the direct reference, by considering that *objects* and *properties* are propositions' constituents. This point of view does not, of course, provide a distinction between Armstrongian facts and propositions. For these reasons, I turn instead to works that are in line with the Fregean proposal, while subjectivizing the latter. This amounts to admitting the existence of a content-proposition, while recognizing its abstract character, in other words by opting for an indirect reference. Here, I adopt a point of view (defended notably by Stephen

Schiffer (1992) and Edward Zalta (2001)) according to which the constituents of propositions are Fregean “modes of presentation” of individuals and properties; these modes correspond to the way that subjects conceptualize the individuals and properties. So, from this viewpoint, a proposition like 'Mary sees Paul' corresponds to a structured entity $\langle m(\text{Mary}), m'(\text{Seeing}), m''(\text{Paul}) \rangle_P$, where the m^i correspond to the way the proposition's conceiver thinks respectively of the individual 'Mary', the property 'See', and the individual 'Paul'.³³ The use of modes of presentation is essential for propositions because it enables one to explain that propositions and their constituents exist for subjects even when the concrete entities to which reference is made do not exist (see Iacona, 2013).

This use of modes of presentation is just as fundamental for our events, as it helps to explain the different lives of the events and facts to which the events refer. It is important to remember that past or future events can be thought of at times when the substances to which they refer do not exist. We therefore propose a cognitive theory of events that identifies them (to use Soames' (2014) expression) with “*representational entities depending on the capacity to represent of individuals*”. Like propositions, I identify events with structured entities whose constituents are modes of presentation of entities, *i.e.* the way in which the subject for whom the event exists conceives of these entities. Coming back to my example of the 'Paul's fall' event thought about by Mary, I represent it as the following structured entity: $\langle m(\text{Paul}), m'(\text{Enacting Fall}_{\#i}) \rangle_E$ where m and m' respectively represent the way Mary conceptualizes 'Paul' and the relational property 'Enacting Fall_{#i}'. Constituents, in turn, are to be identified to intentional individual. It should be noted in this connection that the notion of 'presentation mode' makes it possible to integrate descriptions of the target entity, for example for $m(\text{Paul})$: 'Mary's husband', 'Christopher's father' (Zalta, 2001).

Let me continue my characterization of events by referring to a property that usually qualifies them as “occurrences”, namely the fact that they may occur (e_{ii}). Intuitively, to say that an event “occurs” means that something happens – something consisting in the realization of the event. What exactly happens corresponds to lives of substances. Consider as an example of event a football match. The event's occurrence (or “realization”) is play between two teams on a field, under the supervision of a referee. More formally, I define this property as follows:

Let e be an event that exists for a subject s at a time t (e corresponds to a history built up from a series of facts): the event e ‘occurs’ at a time t^* iff the facts obtain at time t^* .

Let us illustrate the definition with the example of an event-state: $\langle m(\text{Paul}), m'(\text{Being beside Mary}) \rangle_E$. This event refers to brute facts such as: $\langle \text{Paul}, \text{Being beside Mary}, I \rangle_F$ (I being an objective concrete instant). The event occurs at the subjective

³³ For practical reasons, I use much the same notation as for my facts by adding the letter P as a suffix to the operator $\langle \cdot, \cdot \rangle$ and thus indicating that it is a proposition: $\langle \cdot, \cdot \rangle_P$. Similarly, I use E as a suffix for events, giving $\langle \cdot, \cdot \rangle_E$.

thought time 'Now' or 'Yesterday' iff facts of this type obtain at instants corresponding to this subjective time.

The 'occurrence' property of events can be considered to be analogous to the 'truth' property of propositions (Iacona, 2013): the existence of facts conditions the occurrence of the event, just as it conditions the truth of a proposition³⁴. By analogy with the term 'truth-maker', I suggest using 'occurrence-maker'. For instance, an object displacement event occurs when 'occurrence-maker' facts exist that correspond to a succession of different locations for the object. The order relationship between t and t^* in the definition determines whether the history is past, present, or future. This temporal determination (time t^*) is fixed by the subject thinking the event. In this regard, I must clarify two points. On one hand, an 'event's occurrence' fact depends on beliefs held by the subject thinking the event. On the other hand, the occurrence (in contrast to existence) can be partial.

An 'event's occurrence' fact - for example, $\langle\langle Paul, Falling \rangle_E, Occurs, Now \rangle_F$ - has at its first constituent an event, i.e. an abstract entity.³⁵ It is a social fact (a fact described as "propositional" by Fine (1982)) depending, as such, on a subject's knowledge. Accordingly, I conclude that (i) an event occurrence fact may exist for a subject even when the occurrence-maker facts do not obtain (for example, a television picture may wrongly cause me to believe that a football game I am thinking about has started) and (ii) an 'event's occurrence' fact may not exist even when the occurrence-maker facts obtain (for example, I do not know whether the match I am thinking about and that should have started has really). The belief is incorrect in the first case and lacking in the second.

In general, several facts (rather than just one) characterize the occurrence of an event. Taking my example of Paul's fall, the downward movement of Paul's body can be triggered by (for example) jostling and can be stopped (if, for example, Paul regains his balance), in which case these facts alone may be insufficient for thinking about Paul's fall. If, in contrast, the event exists for a subject, and given that the event's occurrence may depend on a series of facts over time, it follows from my definition that occurrence (unlike existence) may be partial: an event is *ongoing* when, at a time t , only part of the facts characterizing the event obtain or have obtained (e.g., at half-

³⁴ In this regard, we can relate our events to *abstract* states of affairs as characterized by Textor (2016), bringing together the verbs "occur" and "obtain". Textor thus distinguishes the *concrete* states of affairs that exist while obtaining (it is Armstrongian facts) from *abstract* states of affairs which exist in thought and may or may not obtain. Quoting Valicella, Textor states that: *The latter [the abstract states of affairs] are themselves in need of something in the world that explains why they obtain*. He therefore proposes to identify the abstract states of affairs with events: *Now facts can be nothing but states of affairs that obtain and events states of affairs that obtain at some times and not at others*. On the other hand, at the same time, Textor identifies his states of affairs with complexes directly constituted by substances and properties, which differs from our choice for states. We therefore keep the study of this rapprochement for future work.

³⁵ To simplify the notation, I did not include modes of presentation m^i in the constituents of the fact. It will be the same in the rest of the article.

time, a football match has only half occurred). What these examples demonstrate is that events and the related facts live relatively independent lives.

This relative independence leads us to question the criteria of individuation and identity of events. As a criterion of individuation, I still refer to temporally indexed facts: the event 'Paul's fall' is *the* fall which occurred in a given spatiotemporal region, rather than just *a* fall. This reference to an obligatorily single spatiotemporal region leads us to consider that an event is non-repeatable, that is to say that it occurs only once (e_iii). However, the nature of the facts and the boundaries of the spatiotemporal region are generally not specified. Thus the event 'Paul's walk to the station this morning' could give rise to a variety of unspecified facts. In this sense, Steward (2013) speaks of the *mereological robustness* of events, as opposed to the *mereological essentialism* attributed by some theorists. Next, how can one consider the spatiotemporal location of complex events (covering large spatiotemporal regions and several economic and political systems) such as 'the industrial revolution' or 'the Second World War'?³⁶ Now, considering the criterion of identity, a natural candidate would be a structural criterion that corresponds to the identity of the event's constituents. In any case, this type of criterion would be subjective because it is stipulated by a subject. The specification of this criterion will be left for the future. In particular, several issues arise. Firstly, taking into account the presence of modes of presentation, we should consider whether or not the events 'Paul's fall' and 'my husband's fall' are distinct for Mary. Secondly, what about events like 'Paul's sudden fall' or 'Paul's unexpected fall'? Part of the answer to this last question lies in the distinction between the event and its descriptions - a point that I now address with property (e_iv).

To complete the characterization of events, let me mention the fact that events bear properties at times (e_iv).

As discussed in Section 3.2, the properties of events as social objects differ from those of physical objects and processes. In the physical stratum, objects and processes possess properties independently of us. In the mental & social stratum, however, we attribute properties to events by stipulation. Ontologically speaking, these attributions by stipulation correspond to social facts. More precisely, some of these facts are based on an event's "internal" properties, by reference to facts that the event accounts for (e.g. *the event involving Paul, the event that occurred this morning*). Thematic conceptual roles – *agent, patient, object, instrument*, etc. – used in action descriptions are examples of internal properties. Other social facts mention "external" properties unrelated to the content of the event (e.g., *the event that surprised Mary, the event Mary told me about*). The social facts that I have just mentioned clearly correspond to multiple descriptions of the same event. Some of these descriptions (such as *the walk that Paul did not go on this morning*) have been described as "negative" in the

³⁶ This indeterminacy of events is emphasized by (Varzi, 2002), who gives a different explanation, however. According to Varzi (a defender of a Davidsonian conception of the event), indeterminacy and vagueness come from the way we speak of events, i.e. the descriptions that we use in language. In contrast, I consider that indeterminacy is intrinsic to the event because it is a representation or abstraction of the world.

literature. Pragmatically, one can imagine that Mary could conceive this thought because she knows that (i) Paul usually walks to the station in the morning, and (ii) Paul did not walk to the station on that morning. I therefore consider that a negative description amounts to attributing a ‘non-occurrence’ property to an event.³⁷

Lastly, let us consider events’ changes over time, our property (e_v). As Nicola Guarino (2017) recently pointed out, the current view is that events carry their properties timelessly (according to some researchers, this characteristic even distinguishes events and processes): *According to the standard wisdom, all temporal occurrences are considered as “frozen in time”. This means that all their properties are fully determined, and they can’t change (ibid., 477).* Yet, as Guarino also notes: *This is certainly true for historical occurrences, but, at least in the ordinary language, ongoing and future occurrences seem to admit the possibility of change: the score of an ongoing match may change in time, and a future trip may be delayed (ibid., 477).* My position is that events’ properties are tensed, which thus provides all events with the opportunity to change. As noted above, assigning properties to events corresponds to making judgments. Judgments related to past events are well established and unlikely to change - unless new historical elements lead us to review them. Descriptions of past events do not therefore depend on time. In contrast (and I agree with Guarino in this respect), things are different for current (and even future) events. The reason is that judgments made about an ongoing event may depend temporarily on how the event is carried out: a football match that is boring at an instant *t* (because the opposing teams are sizing each other up in the early stages of the match) can become exciting at a later instant *t'* (when the players have freed themselves of their initial stress, and the match has truly "taken off").

3.4. In summary

To conclude this section, let us summarize (see Fig. 2) the path I have taken since my starting point – Galton (2008)’s distinction between *experiential* and *historical* entities.

As a first step on this path, and after postulating that the world as we conceive it is structured into two main strata (the physical stratum and the mental & social

³⁷ This conception of negative descriptions can be likened to that proposed by Varzi (2006), based on a Davidsonian notion of events. By referring to an event, Varzi is forced to admit its existence. If an event does not exist, and in the case where a planned event is not replaced by a significant event (for example, Paul ran (rather than walked) to the station), the disadvantage of Varzi’s argument is the consideration that this type of negative description is ‘*strictly and literally false, albeit in a way that admits of true paraphrases*’. According to my conception of the event, my distinction between its (thought) existence and its occurrence places descriptions of event occurrence or non-occurrence on the same epistemological level: the descriptions may be indifferently true or false.

stratum), I positioned processes (as experiential entities) in the physical stratum and then events (as historical entities) in the mental & social stratum.

In the physical stratum, processes join objects by sharing a status of substance hitherto reserved for the latter. In short, a process exists in its full identity at instants, and can change over time. Processes and objects are linked by an enactment relationship but bear different properties, which justifies distinguishing between them. Moreover, tensed facts (which I consider to be instantaneous facts) are also in the physical stratum. These facts have been left out of the commonly established inventories in applied ontology but belong to the life of objects and processes - they obtain at instants simply because objects and processes persist over time - and complete the landscape of experiential entities. Some facts account for the world's statics and others (such as process enactment facts and process perpetuation facts) account for its dynamics.

In the mental & social stratum, events are cognitive and, as intentional world-directed individuals, have a specific role (accounting for the life story of substances) for the subjects who make them exist. By their very nature, events are descriptions of facts that involve substances as constituents. Unlike brute facts, the constituents of events are not directly concrete substances but entities corresponding to the way subjects think about these substances. The existence of concrete substances is therefore not correlated with the existence of events. One important property of events is that they occur when facts realize them (that is, when occurrent-maker facts obtain).

This overview enables us to definitively settle the question of how to deal with phenomena like 'Writing a letter', 'Filling out a form' or 'Giving a lecture'. A common analysis of this type of *telic* agency (including an end in itself) is to identify an event and the process that constitutes the event. As shown by Coope (2009), this type of an analysis is clearly inherited from the Aristotelian analysis of processes and has since been reinforced by the thesis whereby events are constituted by processes.³⁸ This heritage (in which one considers that telic processes are intended to end in a complete event) has been endorsed by Charles (2018). According to my ontological framework, one indeed identifies an event; however, our non-telic conception of the processes prohibits us from considering 'macro' processes. Instead, I consider that the realization of agency phenomena (such as 'Writing a letter') gives rise to many physical processes (*e.g.*, hand gestures, processes involving a pencil, etc.). The event is not *constituted*

³⁸ Coope (2009) reminds us of two important features of Aristotle's analysis of change. On one hand, each 'potentiality' refers to a final state in which the substance must culminate: a bronze, in a sculptor's studio has the potential to become a statue; bricks have the potential to become a building. Moreover, all changes occur in the context of an agency phenomenon; an agent is present to "set the course", in a way: *An actuality that is a change must, then, be directed at some new state. What makes it possible for a change to exhibit this kind of directedness is an agent that is responsible for a change.* This also prompts Coope to say that the telic conception of change promoted by Aristotle does not make it possible to account for accidental phenomena: *Consider, for instance, a dead leaf that is blown across the street by the wind. Is it really plausible to suppose that its movement is the actualisation of some specific potential it has for being on the other side of the street?*

by these processes but is *realized* by them when it occurs. Concrete occurrence-maker facts implying these processes obtain (*e.g.*, positions of the hand and the pencil, inscriptions placed on a sheet) which contribute to the realization (occurrence) of the event.

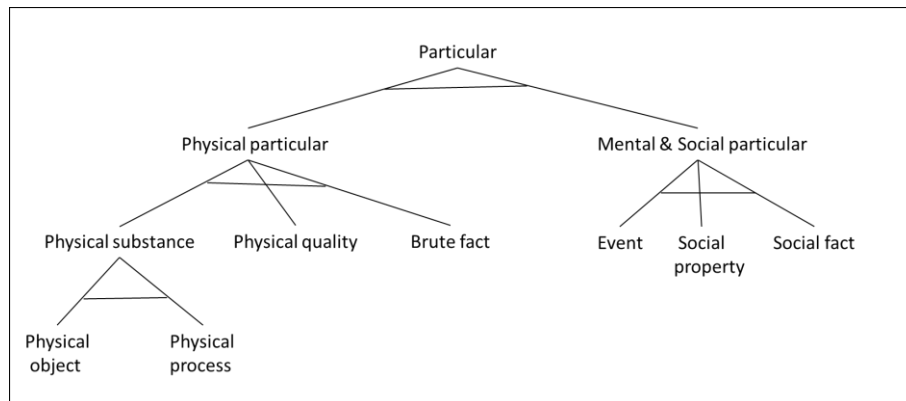


Fig 2. An overview of my ontological framework

4. Concluding remarks

In this article, I laid the foundations of a new ontological framework – one that accounts for the domain of ‘occurrent’ entities. The framework’s innovative character is mainly due to its commitments for *process* and *event* primitives. Rather than interpreting the notions of *ongoing process* and *completed event* as two descriptive ‘perspectives’ of the dynamics of the world (as other researchers often do), I account for them as entities within two distinct strata; in the physical stratum, *processes* rub shoulders with *objects* by sharing modalities of persistence with them; in the mental & social stratum, events are credited with an existence prior to their occurrence. The framework’s innovative character is also due to its recognition of the existence of *facts* and the *occurrence-maker* status granted to these facts.

I am aware that this framework is based on minority views (in terms of both the ontology of processes and the ontology of events), although I have taken care to demonstrate that all these views have a pedigree in formal ontology. Further work is therefore needed to evaluate and complete my framework. To this end, I have identified several possible projects.

The framework provides us with a pattern of analysis that is applicable to each level of the physical stratum: ‘physical objects enact physical processes; objects and processes enjoy a life, bearing properties at instants; their life story is conceptualized by subjects through events’. A level-by-level inventory should tell us whether or not the framework is universal.

At this stage, we have especially highlighted the similar natures of objects and processes, and have specified that the only difference is that processes are enacted by

objects. However, we did not draw out the consequences of this enactment. The role played by processes in the dynamics of the world remains to be shown. A process produces effects, which correspond to a series of facts (a Cambridge change). This means that there is a causal relationship between processes and brute facts. We have yet to characterize this relationship.

According to our presentist theory of time, each fact in a Cambridge change obtains at an instant. In contrast, a series of facts extends over several instants but does not exist physically *per se*. To support the existence of a series of facts, we hypothesize that the series is an abstract event. We justify this as follows, for the case of a movement. An object's series of successive locations corresponds to a spatiotemporal trajectory that our perceptual and cognitive apparatuses prompt us to objectify; a movement can be likened to a trajectory to which we attribute a shape, as evidenced by expressions like "rectilinear/rotary/oscillatory movement". When a person moves by walking, the characteristic, regular, repeated arm and leg movements gives the walking a shape. This thought movement can be linked to the notion of *abstract process as a pattern of occurrence* recently promoted by Galton (2018). We believe that this notion has its place in our ontological framework to define a kind of continuous change as an abstract event.

Lastly, let us mention a project that can be considered more fundamental, because it concerns the nature of the properties-relations. As we have just recalled, our framework supposes the existence of facts, a category of entities that we have split in two, distinguishing between *brute* facts and *social* facts. This distinction is ontological in nature and we made it depend on the nature of the properties-relations, physical (or natural) or conceptual. Some authors, such as Arianna Betti (2015), have been skeptical about the existence of facts by basing their doubts on the nature of properties-relations. In particular, to stick to the brute facts, how can we say that a relation like 'Being beside' connects its relata? In other words, in a situation where two substances 'Paul' and 'Mary' are in close proximity to one another, does this empirical truth correspond to a distinct entity that complements the furniture of the physical world, in this case a fact that we noted $\langle \text{Paul}, \text{Being beside Mary} \rangle$ F? A common point of view in philosophy (since Russell) is to consider that spatial relations such as this contribute ontologically to the world (technically, these relationships are qualified for this reason from *external*). But another point of view can be put forward: that from the moment when two physical objects exist and have a location in the physical world, relations like 'Being beside', 'Being left', 'Being at 50 centimeters', etc. bring nothing on the physical world (these relations, depending only on the spatial location of the objects would be described as *internal*). In other words, these relations would be conceptual and we would qualify the corresponding facts as social. Our feeling is to have been very (too) lax in Section 3.2 in our recognition of

physical facts. This remark prompts us to look more precisely at the criteria defining the physical character of the properties-relations.

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