

# Processes endure, whereas events occur<sup>\*</sup>

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**Abstract.** In this essay, we aim to help clarify the nature of so-called 'occurrences' by attributing distinct modes of existence and persistence to *processes* and *events*. In doing so, we break with the perdurantism claimed by DOLCE's authors and we distance ourselves from mereological analyzes like those recently conducted by Guarino to distinguish between 'processes' and 'episodes'. In line with the works of Stout and Galton, we first bring closer (physical) processes and objects in their way of enduring by proposing for processes a notion of *dynamic presence* (contrasting with a *static presence* for objects). Then, on the events side, we attribute to them the status of abstract entities by identifying them with objects of thought (by individual and collective subjects), and this allows us to distinguish for themselves between *existence* and *occurrence*. We therefore identify them with psychological (or even social) endurants, which may contingently *occur*.

**Keywords.** Processes, Events, Objects, Facts, Endurance, Occurrence, Intentional ontology

## 1. Introduction

'Occurrences', those entities that are said to 'happen', have been the subject of renewed analyzes in Formal Ontology for a few years. Named also 'perdurants' or 'eventualities', they correspond to entities as diverse as *processes*, *events*, *states* and *changes of states*. According to Antony Galton [13], these efforts are beneficial because, even today, we find in literature as many classifications as there are authors and the problem is not so much the choice of criteria as our imperfect understanding of their nature.

Significant work has been done independently by Rowland Stout [36][37] and Galton [12][13], in the late 1990s and early 00s, to clarify the nature of *processes*. They have indeed proposed a new conception of processes bringing them closer to objects in their way of enduring in time by being 'wholly' present at every moment of their lives. Their proposal is the subject of debate. An important issue (in the eyes of debaters) is whether the processes are, or not, entities extended over time. If so, according to Helen Steward [34][35], processes would remain 'occurrences', sharing some features of continuants such as being able to change properties over time. Otherwise, according to Stout [38], processes would be, so to speak, 'dynamic' continuants.

Nicola Guarino is also one of the researchers working to clarify the nature of the occurrences. As co-author of DOLCE, he proposed a perdurantist analysis of the occurrences [27]. Recently, starting from work with Giancardo Guizzardi and João Paulo

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Almeida concerning the conceptual modeling of business processes [20], he proposed to refine the mereological theory of the perdurants of DOLCE in order to better characterize two categories of occurrences, 'processes' and 'episodes' [19].

For our part, we have recently seized on the subject by developing an ontological framework strongly inspired by the proposals of Stout and Galton [23]. The originality of our proposal lies in our conception of events: where, traditionally since Donald Davidson [8], the event is conceived as a concrete particular (and Guarino espouses this conception), we attribute on the contrary to events the status of abstract entity by assimilating them to mental entities, even social entities. Historically, this point of view was defended in the 1970s by philosophers like Roderick Chisholm [5] and Neil Wilson [42]. Closer to home, Kathleen Gill argued that the only way to distinguish processes and events in our ontological inventory was to consider abstract events [18]. Fundamentally, in our view, the merit of such a conception is to distinguish between two too often confused notions that are the *existence* and the *occurrence* (in the sense of realization) of events.

In this chapter, we elaborate on our ontological framework, whose basic commitments and main primitives are recalled respectively in Sections 2 and 3. Our intention is to show that it is possible - and even healthy - to approach the clarification of the nature of the occurrences, disregarding the mereological dimension. We focus on processes and events. Concerning the former, we propose to give an account of their endurance by means of a notion of 'dynamic' physical *presence* (to be compared with the 'static' *presence* of physical objects). Concerning the second, we propose to distinguish between the notions of *logical existence* and of *occurrence* to describe them as psychological (even social) *endurants*, which can contingently *occur*. To formulate these propositions, we position ourselves with DOLCE and recent Guarino's analyzes.

## 2. Our basic commitments

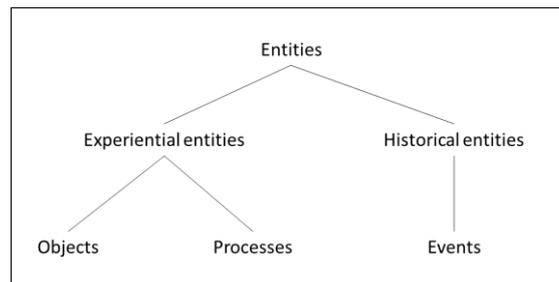
As a starting point, we follow Strawson's (1959) project of establishing a *descriptive* metaphysics to account for "*the actual structure of our thought about the world*". The aim is thus to establish categories and notions that reflect the way in which we conceive the world<sup>1</sup>. Adopting a contemporary perspective of ontology, we retain as the main mode of structuring the world three types of reality: physical, mental and social. This division of reality is based on the recognition of distinct *modes of existence*. It leads us, in our engagements, to track the border between facts and interpretations, as we invite Maurizio Ferraris [9]: "*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.*"

This meticulous work of investigation, we engage in the field of the occurrents. An important first step for us is Galton's proposal to substitute the classic distinction 'continuing' vs. 'occurrent' for the distinction EXP vs. HIST (Fig. 1) between the world as it unfolds and its history [13]: "*[...] processes differ markedly from events in their*

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<sup>1</sup> In this, we join the orientation also retained by the authors of DOLCE. However, we will see later (Section 4) that the need to assign properties to 'non-existent' entities will lead us, beyond a simple 'cognitive bias', to opt for an *intentional* ontology (or *intensional* by reference to intensional semantics).

*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.”*



**Figure 1.** The distinction between *experimental* and *historical* entities (from (Galton, 2008))

According to Galton, this distinction corresponds to two perspectives of description of the world. On the contrary, we propose to see an opposition between the physical world and the mental and social worlds and, more precisely, to position events conceived as historical entities in the mental and social worlds [23]. The argument can be summarized as follows: the history of the world consists of how the world evolves over time; to appreciate changes, or on the contrary stabilities, requires the memory of observers; events are therefore psychological and social constructs.

### 3. Our ontological framework (in a nutshell)

In this section we give an overview of our main ontological primitives<sup>2</sup>. To put them in scene, we follow the following thread:

- The physical world is peopled with substances - *objects* and *processes* - which, by enduring, ensure its stability as well as its dynamicity (§3.1);
- These substances, temporarily bearing properties and maintaining relations with other substances, have a life, which consists of *facts* existing in the physical world (§3.2);
- Cognitive subjects, immersed in the physical world, represent through *events* the past, present and future history of the world in order to interact with it (§3.3).

#### 3.1. The substances

To begin our inventory, we adopt a classic conception of the physical object. A physical physical object is something:

- (o\_i) existing at instants;
- (o\_ii) having properties at instants (*e.g.*: color, odor, mass, volume);

<sup>2</sup> For reasons of space, we do not justify the choice of these primitives and we just deliver an inventory. The reader interested in justifications and positioning vis-à-vis ontological commitments in competition is invited to refer to (Kassel, 2017).

(o\_iii) that may change over time.

These properties express the conception of a 3D entity existing *at* instants and enduring *over* time with properties that can vary over time. The properties (o\_ii) and (o\_iii) characterize the life of the physical object: we return to it in §3.2. In extension, examples are maximally connected objects, whether they are inert (*e.g.*, a stone, an apple detached from a tree, a molecule of water, a planet), animated-alive (*e.g.*, a human being, a flower, a tree) or artifacts (*e.g.*, a chair, a clipboard, a television). In the case of artifacts, we will see in §3.2 that we consider them as physical objects *simpliciter* endowed with a social life.

The characterization we now give of physical processes is largely based on the idea of dynamics continuants developed mainly by Stout [36][37], Galton [12][13] and Galton and Riichiro Mizoguchi [16]. A physical process is something:

- (p\_i) existing at instants;
- (p\_ii) having properties at instants (*e.g.*: direction, speed of execution, sound level, spatial amplitude);
- (p\_iii) that may change over time;
- (p\_iv) *enacted* by a physical object.

We find with (p\_i) (p\_ii) and (p\_iii) the same characterization as for the physical object, in other words that of a *substance* - a substrate bearing properties. In extension, examples of physical processes are: the movement of a physical object (leading to the displacement or rotation of the object on itself); the growth in size of a physical body; the life process of a person; the ripening of a fruit; oxidation of a ferrous metal object; the melting of a glacier.

Property (p\_i) is a strong commitment to the nature of processes. It is found expressed in Stout [36]: “*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.*”

This commitment hinges on the following complementary commitment: the cause is part of the process, which process is the ‘engine’ of change. In the case of a change of location of an object, this change results from a movement of the object - the process. Associating the cause with the process, according to Stout, is necessary to twist the neck of the Russellian conception of a movement as a series of successive states [37]: “*[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.*”

The properties (p\_ii) and (p\_iii) follow logically and continue bringing processes closer to objects, as Galton puts it [12]: <sup>3</sup> “*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 change rhythm, or may stop,*

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<sup>3</sup> We admit, however, that there are limits to this comparison. Indeed, if the change of an object is explained by a process, the change of a process can not itself be explained by a process, unless we create an infinite conceptual regression. We thus agree with Thomas Crowther’s [7] point of view that it is not possible to speak of ‘genuine’ change for processes (in the sense of objects). However, and unlike Crowther (but, for lack of space, we will not develop), we do not see enough argument to deny the processes the character of continuant.

*only to start again later. The flow of the river becomes turbulent; the wind veers to the north-west.”*

To finalize (momentarily) the characterization of our physical processes, let us evoke a last ontological commitment - the property (p<sub>iv</sub>) - namely the fact that a process is not a continuant floating in the air, but is 'anchored' in a *support object*: this is the movement of *an arrow*, the ripening of *a fruit*, the melting of *a glacier*, etc. To account for this strong constitutive link, we take over the *enaction* relationship introduced by Galton and Mizoguchi [16]. For these authors, to say that an object 'enacts' a process amounts to saying that an object carries an "external" or "behavior" process [16]: “*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 *enaction* relation establishes an existential dependence of the process on an object. For the object, as we will clarify, *enacting* processes is part of his contingent life.

### 3.2. The life of substances

Our ontological inventory is at this stage composed of substances - objects and physical processes. Being entities that persist in time while maintaining their identity, they exist at different times and this leads us to talk about their 'life'. Intuitively, this term denotes what happens contingently to a substance between the moment when it acquires an existence and the moment when it ceases to exist. The properties (o<sub>ii</sub>) and (p<sub>ii</sub>) characterize the basic brick of life respectively objects and processes. Note that they assume the existence of *properties*. To dedicate their place in our inventory, we will provide some details on their nature. Moreover, the brick itself expresses a temporal *fact*. Following a conception now well established in metaphysics, we also add this primitive to our inventory. Finally, what we call 'life' of a substance is an accumulation of facts throughout the existence of the substance.

Let's start with the *properties*, and with a terminological clarification: the term "property" is commonly used to denote, on the one hand, the universals (types) and tropes (instances) which characterize substances [1] and, on the other hand, concepts or categories that structure our representations and theories of the world [26]. These entities have different modes of existence and attribution. As we will show later, the coherence of our ontological framework requires us to consider both. In particular, for the notion of life that interests us in this paragraph, we will see that it is relevant to distinguish between 'physical' life and 'social' life of substances. To distinguish them, we will refer to them by using respectively the terms "physical property" and "conceptual property".

We identify therefore, on the one hand, physical properties whose existence is independent of human thoughts (a large treatment of these properties can be found in [1]). Following Peter Hacker [21], we consider that objects and processes bear different properties. The way of being of a physical object, for example of a person, corresponds to properties/relations like: 'Being anxious', 'Being next to Mary', 'Walking'.<sup>4</sup> For a process, examples of properties are: 'Being fast', 'Being noisy', 'Slowing down'. On the other hand, we also identify conceptual properties whose existence depends only on human thoughts [31]. Typically these properties correspond to functions we assign to

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<sup>4</sup> This last property is in fact a relation, that of enacting a walking process. We consider that such a process is expressed by the substantive 'walk', as in 'Paul's walk'.

physical objects (*e.g.*, 'Being a table', 'Being a paperweight') or processes (*e.g.*, 'Being an endorsement', 'Being a threat').<sup>5</sup> We will now see that this distinction of modes of existence among properties is reflected in distinct modes of existence among the facts.

The category of property being introduced, we continue to expand our inventory admitting this time that of *fact*. The thesis of the existence of such entities, advanced by many philosophers (*e.g.*, Kit Fine [10], Donald Armstrong [1]), is a companion thesis of the real theory (to understand by this, of the '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 at this instant the property 'Being anxious', and the same holds true for the substance 'Paul' and the relation 'Being next to Mary'. The fact, or the 'circumstance' (to use Fine's term), corresponds to this internal link uniting, at a given instant, the substance and the property/relation into a separate entity. The main argument for facts' existence is that they constitute a *truth-maker*, that is, what makes true in the world such propositions as 'Paul is anxious' or 'Paul is beside Mary' [1]. It will be noted that we have admitted time as constituent of our facts, thus considering tensed facts. This is consistent with the properties (o/p<sub>ii</sub>) expressing that objects and processes bear properties at instants. Simply, this choice has an impact on the mode of existence of facts. Indeed, since facts exist only at times at which their constituents exist, they exist only at the instant corresponding to their temporal constituent. These are states of affairs 'that obtain' at this instant: they do not endure in time.

According to our distinction between physical and conceptual properties, as we suggested, we distinguish between 'physical' facts (or 'brute' facts, to use Searle's terminology) and 'social' facts. The formers have an existence independent of all human thought towards them: the fact that 'Paul is next to Mary now' has a physical reality independent of what Mary can think. The seconds, on the other hand, are human constructs. The association of a property with a substance corresponds to a human stipulation that can be based on a social convention. To use Searle's analysis and its expression "count as" to denote the result of this stipulation [31]: this piece of paper *counts as* 'Being a 10 euro banknote' (for an agent or a community of agents, under certain circumstances); such pebble *counts as* 'being a paperweight'. Different analyzes of social facts have been proposed in the literature (*e.g.*, [40]). Searle's is given here as an example. The essential thing for us is to emphasize that the life of substances is not limited to their physical life but that it also involves for subjects a social life.

Before closing this paragraph on the 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. We have already mentioned a first category with the property (p<sub>iv</sub>) expressing the fact that every process is enacted at every instant by an object. These facts of process enaction are part of the 'processual life' of objects. A second category of facts concerns this time the very life of processes. It is about the fact that processes can *perpetuate* each other, in a phenomenon of propagation of causality (we take up here a relation identified by Galton in his inventory of causal-like relations between processes and events [14]). For example, a moving air mass can 'perpetuate' the movement of a leaf, or the movement of a person's arm can 'perpetuate' the movement of

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<sup>5</sup> The processes in question may be respectively a movement of the head and a movement of the fist. According to Amie Thomasson [40], we assimilate artefactual (or at least functional) objects and processes to 'concrete social' entities, that is to say, to physical entities on which the social occurs.

his/her wristwatch. These facts of enaction and perpetuation of processes, by participating in the dynamics of the world, can be said to 'occur'. Note that they are not usually included in inventories of occurrences, being neither *processes*, nor *events*, nor *states*, nor *changes of states*. Their role in explaining the dynamics of the world is in any case an additional argument in favor of their existence (completing the 'truthmaker' argument).

### 3.3. *The life history of substances*

By evoking the social facts, we began to clear the world of mental and social constructs. In this section, we continue in this direction by focusing on a specific category of constructs: life histories of substances - objects and processes - populating the physical world. The main ontological category that we will add to our inventory is that of *event*. Historically, in the 1970s, authors such as Chisholm [5] and Wilson [42] proposed to conceive of events as abstract entities. Yet the metaphysics of the states of affairs were at that time in its infancy, and this explains the limits of their propositions. We are taking advantage today of advances, notably in the field of ontology of facts, to propose a more solid theory.

We consider that an event is something:

(e\_i) existing for a subject at instants;

(e\_ii) that may *occur* ;

(e\_iii) having properties at times;

(e\_iii) that may change over time.

Before discussing these properties, take care to characterize in extension the class of events. The diversity of events is due to both the number of substances involved and the length of their lives taken into account.

Basically, to conceive of the history of the life of substances amounts to considering a slice of their life bounded in time. This mechanism has been described by Galton and Mizoguchi, with the aim of distinguishing between *processes* and *events* (2009, 75): "*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 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 can be: 'the first 10 seconds of Paul's race'. For a person, we can evoke 'Paul's childhood' (the slices of life of people we usually refer to are many, *e.g.*, adolescence, youth, retirement, old age).

By staying focused on the history of a particular substance, another category of events concerns the evolution of substances in one aspect. *States* express a stability in time, for example: 'Paul's fatigue of this morning' (for an object); 'The slow pace of Paul's walk during the first 5 minutes' (for a process). The *changes*, on the contrary, reflect a modification of an aspect of a substance, for example: 'Paul's journey to the station this morning' (for an object); 'The blazing acceleration of Paul's run in the last 100 meters' (for a process).

Finally, still in extension, some events concern the life of a large number of objects and processes, such as: 'The assassination of Caesar on March 15, 44 BC. J.-C. ' ; 'the sinking of the Titanic in the night of 14 to 15 April 1912 '. Some events, like the ones we just mentioned, have a social dimension. Others have a more private dimension, such as 'my last bike drop'. As these examples show, some events are intentional, others not. We

argued in Kassel (2018) that the actions we plan and realize (for some of them) are an important class of events. Among these are individual actions (*e.g.*, 'my writing of this essay') and collective actions (*e.g.*, 'the FOIS 2018 conference').

Let us now turn to the intensional characterization of our events, and first of all the thesis (e\_i) according to which events are abstract entities.

The weaker thesis according to which certain events are mental constructs seems evident to defend. The argument is the importance of distinguishing between *existence* and *occurrence* (or *realization*): a football game, no more than a conference, can not be improvised; these events must be socially planned so as to be realized. The stronger thesis that *no* event is concrete is more difficult to justify and, failing to identify a decisive argument, we go forward two reasons: (1) failure to find examples that would not be covered by our current primitives, and according to a principle of economy, it does not seem opportune to open our inventory further, especially since (2) it should be noted that our category of 'brute fact' already makes it possible to account for the dynamics of the world with facts as those of process enaction by objects and process perpetuation (cf §3.2).

Let us continue our characterization of events by referring to a property that usually qualifies them as 'occurents', namely the fact that they may 'happen' (e\_ii). Intuitively, to say that an event 'occurs', or is 'in progress', means that something happens which consists in the realization of the event. The occurrence of a football match consists of the play of two teams on a field, under the control of a referee. More formally, the definition that we retain of this property is as follows:

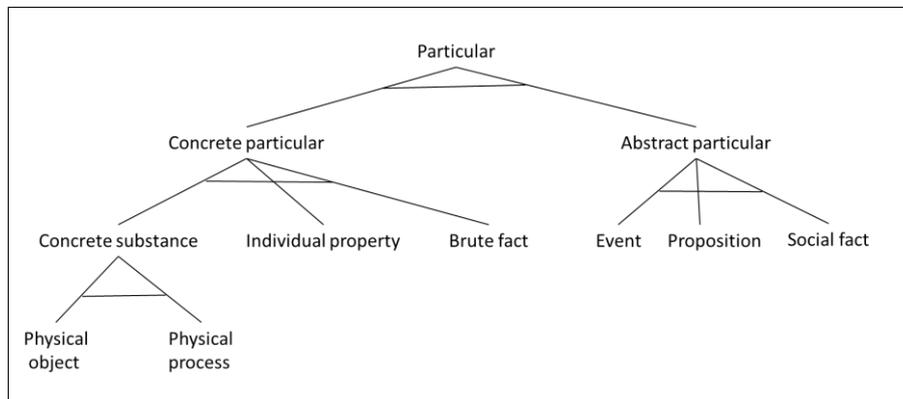
Let *e* be an existing event for the subject *s* at time *t*; the event 'occurs' at a time *t'* iff the facts of which history is related exist at time *t'*.

The *occurrence* property of events may be considered analogous to the *truth* property of propositions [22]: the existence of facts conditions the *occurrence* of the event, as it conditions the *truth* of a proposition. We propose to use the term 'occurentmaker' by analogy with 'truthmaker'. A person's displacement event occurs when a series of 'occurentmaker' facts exist corresponding to different and successive locations for the person. The order relationship between *t* and *t'* in the definition determines whether the history is past, present, or future (we develop these points in Section 4).

Let's come to evoke the way for events to bear properties. As Guarino has recently reminded us, the current point of view is that events carry their properties timelessly (for some authors, this characteristic distinguishes even the processes from events) [19]: "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." Yet, as he also notes [19]: "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." Our position, with the properties (e\_iii) and (e\_iv), is to consider that the properties of events are tensed, giving all events the possibility to change. A justification will be given in Section 4, we provide here the general idea. These properties are conceptual properties and their attribution to events at given times corresponds to judgments. Where judgments relate to past events, these judgments are well established and are unlikely to change (unless new historical elements lead us to review our judgments). Descriptions of past events therefore do not depend on time. On the other hand, and we join Guarino on this point, for current (and even future) events, things are

going differently. The reason is that judgments made about an ongoing event may depend temporarily on how the event is performed: a *boring* football match at a moment  $t$  (because the teams are watching at the beginning of the match) can become exciting at a later time  $t'$  (when the teams are released from the stress of the beginning of the match and the match is "started").

In summary of this Section 3, and before going into the issues of existence and persistence of processes and events, Fig. 2 summarizes the progress made since the Galton (2008) experiential-historical distinction that has served us starting point. Our ontological framework consecrates a physical world populated by enduring substances, (static) objects and (dynamic) processes, whose instantaneous life consists of facts that obtain at instants<sup>6</sup>. World history, for its part, consists of psychological and social constructs accounting for changes (as well as stabilities) of the world over time.



**Figure 2.** Overview of our ontological framework

#### 4. Processes and events' modes of existence and persistence

In this section, we specify the modes of existence of physical processes and events and this leads us to specify (revisit) the notions of *endurance* and *perdurant*. Before turning our attention to these entities in particular, an observation is needed concerning our ontological framework - it places on the same foot concrete and abstract entities - and this questions us on the type of ontology to be adopted: extensional, intensional or mixed? In preamble, in §4.1, we argue in favor of an intensional ontology, which leads us to specify the notion of *endurance* applied to physical objects.

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<sup>6</sup> This vision is to contrast with that proposed more recently by Galton [15]. A point of divergence, corresponding to the debate we were discussing in the introduction, concerns the nature of the processes that Galton considers to be extended entities (p.167) "(...) processes, being inherently temporally extended, can only exist over intervals, not at instants". The question concerns more precisely the ontology of time, of which Galton gives us different facets in [15]. We will content ourselves with saying here that, according to our conception of *instants*, they are certainly indivisible entities, but which nevertheless have a duration. What to relativize, in our eyes, the point of divergence.

#### 4.1. Logical existence, physical presence and endurance

As a starting point, let us return to physical objects, which constitute the paradigmatic figure of continuants. These objects are said to “wholly exist at any time of their existence” (an expression used by Stout to characterize physical processes). First, we adopt Fine's [11] analysis of this expression. A merit for us from his analysis is that it is abstract from any merological discussion (this will prove important for our characterization of process endurance).

According to Fine [11], the meaning of the expression “*o* is wholly present”, in the case where *o* holds for a 3-dimensional physical object, is based on two notions that are to be distinguished: the fact of *existing* and, by this fact, that of *occupying* a spatial region. Still according to Fine, the existence of an object is not a matter of degree (an object exists or not), while its spatial extension can conceptually admit degrees: one can thus consider that *o* *wholly* occupies the spatial region in which it is extended, while occupying only *partially* parts of this region. The expression “*o* is wholly present” is therefore to be understood in the sense of '*o* exists and *o* is fully extended spatially'. If we leave aside, for the moment, the notion of spatial extension, it remains to specify that of existence.

In the literature, several notions of existence are evoked, in any case several terms are used: 'logical existence', 'ontological existence', 'physical presence'. In DOLCE (we take as reference the core DOLCE-CORE revisited by Borgo and Masolo [3]), the logical existence is granted to temporal entities. In addition to physical objects, the domain of discourse includes abstract entities such as *regions of magnitudes of qualities* or *concepts* (these abstract entities are considered to be able to enjoy a life by being created, modified and abandoned). Among the discourses made about the entities are those relating to their period of life, for example "Paul lived from 1925 to 2008" (time is also part of the discourse domain). This presence is represented by means of the predicate  $PRE(x,t)$  used to identify at what times *t* the entity *x* is present. This predicate makes it possible to express that Paul was present neither in 1920 nor in 2015, but that he was present on dates between 1925 and 2008. The presence of an object at different times – e.g.:  $PRE(\text{Paul}, T_1) \wedge PRE(\text{Paul}, T_2)$ ,  $T_1$  and  $T_2$  being between 1925 and 2003 - reflects its endurance over this period. In the case of a general formula  $F(x, t)$ , Borgo and Masolo refer to the meaning proposed by Trenton Merricks [29]: “*x* exists at *t* and it has the property *F* when *t* is (was, will be) present”. Since the subexpression “*x* exists at *t*” is synonymous with “*x* is present at *t*”, the following axiom is assumed:  $F(x, t) \rightarrow PRE(x, t)$ .

These ontological commitments raise several problems. One problem, highlighted by Guarino [19], is that we cannot assign properties to *x* at times *t* where these *x* are not present. According to Guarino [19], this possibility is necessary for events “For instance, if *x* is an event that occurs at  $t_0$  (say, a person's birthday), it may be *expected* at a time  $t_1 < t_0$  only if *x* is *not* present at  $t_1$ , and *remembered* at a time  $t_2 > t_0$  only if *x* is *not* present at  $t_2$ , since we can't expect nor remember something that is present”. It is as much for physical objects [19] “Similarly, a person can have various properties, such as being admired or being the mother of somebody, also when she is not present anymore since she is died”. A more general problem that we raise, related to the previous one, concerns the absence of distinction between *logical existence* and *ontological existence* (taken in the sense of *physical presence*). This distinction is critical for our ontology of events, identified with abstract objects. DOLCE-CORE's strategy is to admit abstract objects into the domain of discourse. They therefore enjoy a logical existence and, as such,

belong to the domain of the predicate  $PRE(x, t)$ . The problem is that this predicate, whose role is to locate entities in time, turns out to be of no use (has no meaning) for events. For events, we need to express a notion of *occurrence* that is different from a *location* in time (see §4.3). For physical objects, we affirm that this distinction is equally important (to solve the problem raised by Guarino), but on the condition of interpreting the predicate  $PRE(x, t)$  as a physical presence/existence.

To meet these needs, the proposal we make consists, first of all, in considering that our domain of discourse is populated only by objects of thought<sup>7</sup>. In the domain of semantics, this amounts to adopting a cognitive semantics [17] deemed to be able to speak of entities that “do not exist”<sup>8</sup>. On an ontological level, for physical objects, this leads to distinguishing the object of thought  $Paul_{OoT}$  and its physical correlate  $Paul_{PO}$ , namely the physical thing to which the object of thought refers. On the contrary, events are objects of thought that have no physical correlate. To characterize this difference, in a second step, we modify the semantics of the predicate  $PRE(x, t)$ . The new predicate  $PRE'(x, t)$  that we propose has for domain objects of thought referring to physical things, and for significance: “the physical correlate of  $x$  is present at time  $t$ ”. In this way, the physical endurance of a physical object is represented by the fact that its correlate is present at different times, for example:  $PRE'(Paul_{OoT}, T_1) \wedge PRE'(Paul_{OoT}, T_2)$ .

Let's complete our theory of physical endurance. As stated in Section 3, we admit that the same object (to understand, the same physical thing)  $O$  can be  $F$  to  $t$  and not  $F$  to  $t'$ . This conception exposes us to the famous objection (formulated notably by David Lewis [25]) concerning the impossibility for a physical object to endure (in short, if  $O$  is  $F$  at  $t$  and not  $F$  at  $t'$ , discernability implies that the  $O$  cannot be identical). We will content ourselves with noting that Lewis's argumentation calls for a merology of the object conceived as a 4-D entity. On the contrary, as indicated above, we follow Fine's conception by defending a 3-D theory of the physical object. For our conception of the *physical identity* of the object, we rather choose to base ourselves on a notion of *essence* of the object (by identifying the essence  $E$  of an object  $x$  with a property satisfying both conditions (1) it is not possible for  $x$  to be present without  $x$  being not  $E$ , and (2)  $E$  is unique to  $x$  so that there is no distinct  $y$  of  $x$  that bears  $E$ ). In fact, to say that the *same object* endures amounts to saying that the *same essence* is present at different times. Changes in the object therefore only concern its *contingent* properties.

#### 4.2. Physical processes endure

Let's come to characterize how physical processes exist and persist. We have seen in Section 3 the role we attribute to the process in the conceptualization of change. Precisely, a process is a concrete particular at the origin of the evolution of a physical object, this evolution corresponding to a series of facts, which series can be observed and conceptualized as a change. To repeat Stout's thesis, and illustrating it on a change of

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<sup>7</sup> In Section 2 we indicated that we intended to develop a descriptive ontology, in Strawson's sense. The choice we make here to opt for an *intensional* ontology goes in this direction. It will be noted that historically, and for reasons similar to those we have just stated in the preceding paragraph, such choices were made by Castañeda [4] (with his 'epistemological' ontology) and by Chisholm [6] (with his 'intentional' ontology). Our *objects of thought* can be compared with the *individuals* of Castañeda but also *abstract individuals* of Edward Zalta [43].

<sup>8</sup> Discourses can relate to the house of Paul whereas this one does not exist yet (eg, "the house that Paul will make construct will comprise a broad terrace") or while it no longer exists (eg, "there is nothing left of Paul's house but a brick wall threatening to fall").

location of an object, when a person moves while walking, a walking process is “wholly present” at any moment during the displacement, provided that the latter is uninterrupted.

This 'whole' presence is to be compared with that of physical objects at any moment of their existence. As with objects, we adopt Fine’s strategy to distinguish between physical existence and the resulting temporal occupation. Regarding the physical existence, for which we retain an identity based on an essence, to differentiate the object of the process, we propose to distinguish, on the side of objects, a 'static' presence and, on the side of processes, a 'dynamic' one. To represent this dynamic presence, by borrowing a current terminology, we introduce the predicate  $OPE(x,t)$  meaning that “ $x$  operates (or is active) at time  $t$ ”. The endurance of processes is therefore rendered by the fact that a 'same' process (in the sense of an essence) operates at different times, for example for a walking process  $WLK_I$ :  $OPE(WLK_I, T_1) \wedge OPE(WLK_I, T_2)$  ( $WLK_I, T_1$  and  $T_2$  being objects of thought referring to physical entities).

According to our characterization of processes, every operating process is enacted by an object concomitantly statically present, which constitutes a dependence of physical existence. In his theory of the endurance of physical objects, Peter Simons [33] has proposed, conversely, that all objects depend on processes. According to Simons [33]: “*for a human being or other animal the relevant processes are those which are vital to it, which are a (probably not exactly delimited) collection of occurrents in its life, involving respiration, blood transport, nutrient breakdown and the chemical reactions within the cells. These are all processes which have to go in order for an animal to continue to exist*”. In the case of inert objects like a stone [33]: “*The widespread cohesion of the crystals in the rock which hold it together as a mechanically unified mass depend on chemical bonds among atoms*”.<sup>9</sup> According to this conception, processes and objects are mutually dependent for their physical existence. We hold this mutual dependence as a sign of the same notion of *presence* that specializes in *static* and *dynamic*. Recall that this concept of presence, on which we base our theory of endurance for the physical objects and processes, abstracts from any mereological analysis for these entities.

#### 4.3. Events logically endure and contingently occur

Let's come to events. Since our conception of events is not classical, by not following the dominant (Davidsonian) thesis of concrete spatio-temporal individuals, we must expect that our characterization of their modes of existence and persistence will no more be so. Precisely, as we started to see in §3.3, we propose that events exist and persist logically. On the other hand, as regards the link with the physical world (of which they tell the story), where, for the objects and processes, we have retained a physical *presence*, for the events we retain an *occurrence* corresponding to a notion of *physical realization* by facts.

As objects of thought, events enjoy a logical existence and identity. They exist at times for subjects but this time is distinct from the times of physical presence of the

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<sup>9</sup> A close analysis has also been proposed by Galton and Mizoguchi [16]: “*Although a simple rock may seem inert and lifeless, in fact it exhibits some remarkable behaviour. If you live it alone, it twill just sit there – but significantly, it stays in one piece. The maintenance of the rock’s integrity is a process: from the point of view of the rock, it is an internal process enacted by the constituent grains of the rock (...) whose mutual cohesion holds the rock together*”.

objects and processes of which they relate the history.<sup>10</sup> In fact, compared to the time they are thought of, events can be *spent*, *in progress* or *future*. Their identity is determined and maintained by stipulation by subjects (individual or collective).<sup>11</sup> We can talk about endurance about them. Thus the community of philosophers of action has become accustomed to perpetuate the event of Brutus' stabbing of Caesar. Here is an example of an event whose longevity is exceptional. The events corresponding to actions that we carry out daily (*e.g.*, the fact that 'Paul has buttered a toast this morning') have a shorter life span. The endurance of events causes them to change by carrying properties that are contrary at different times: an event *expected* at a time *t* may no longer be at a time *t'* (especially if it has occurred in the meantime).

One theory usually advanced to account for the persistence of events is *perdurantism*. The reader will have understood that the logical persistence of which we have just spoken, which takes no account of a mereology of events, is foreign to the fact, for an entity, to exist only by its temporal parts and to persist in accumulating parties, which is the foundation of perdurantism. On the other hand, perdurantism has a relevant intuition that we wish to preserve, namely that an ongoing event "exists only partially". The idea is that when an event is in progress (for example a football match has started), at any moment that the event lasts only a 'part' of the event 'exists'; past parts of the event no longer 'exist'; other parts are coming and do not 'exist' yet. This intuition seems to us important to preserve, however we attach it to our notion of *occurrence*. The interpretation we give of an ongoing event is that the event "is *realized*, but only in *part*". The notion of a *part* of an event must therefore be elucidated.

First of all, to say that an event is ongoing at a time *t* is to say that facts exist realizing the event. In §3.3, we qualified these facts as 'occurrentmakers', by analogy with the term 'truthmaker'. Let's take our example of football game. At the moment the event is in progress, it exists socially for both the players and the spectators. It existed long before the referee whistled the start of the match, to the point that the players were prepared and that the spectators were organized to attend. Its occurrence corresponds to the game of teams on the field, the fact that many processes operate generating occurrentmaker facts. To the question "what facts realize an event?" it will be noted that the same event can be accommodated in its realization of very different facts. Thus, for our example of match, according to the hazards of the game, the facts realizing it will be varied. In some cases, a balanced score at the 'normal' end of matches may result in an extension. More fundamentally, we will note that, an event being a social entity, its definition necessarily includes social uncertainty: in particular, does a football match start strictly with the teams' play or when spectators enter the stadium? In this sense, we can affirm with Achille Varzi that an event is a largely *indeterminate* entity [41].

In addition, a 'partially' realized event is an event of which only a 'part' is realized. The notion of *part*, in the case of physical objects, is based on a notion of *spatial inclusion*: a *part* of an object occupies a spatial region included in that occupied by the global object. In the case of events, the notion of inclusion can be retained, however the temporal dimension must be taken into account and it must be considered that the spatio-temporal region concerned is that occupied by *facts*: *part* of an event is such that the facts

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<sup>10</sup> Events may also involve fictional objects such as those corresponding to Sherlock Holmes' reported exploits.

<sup>11</sup> In this text, for reasons of space, we elude the distinction between *psychological identity* and *social identity*. The reader may consider that social identity is constructed from psychological identities according to a mechanism of collective recognition as described by Searle [31].

realizing it occupy a spatio-temporal region included in that occupied by the facts realizing the global event. An example of parts of events corresponds to slices of life of substances on interlocking periods: the *childhood* and *adolescence* of a person are part of his life. Another example of parts is given by intentionally realized events (actions) for which a plan, that is a structure in sub-events, is specified. A football match is thus a conventionally structured event: two periods of play succeed one another, interspersed with a half-time; at half-time, we can say that the match is only "partially" realized. In general, to specify the criteria for the unity of events, we must expect to encounter the same difficulties as for physical objects.

## 5. Conclusion

In conclusion of his [19], Guarino launches the motto 'Let's defrost events!' to defend the idea of considering *ongoing* and *future* events as first-class citizens. The conception of the events that we have just presented goes in this direction since, by assimilating them to abstract entities, we confer on all events (past, current, future) the same mode of existence. In this regard, it should be noted that this status of objects of thought that we attribute to them does not mean - as some philosophers argue - second-class citizens (Joseph Melia's [28] attempt to eliminate the events from his ontology is an example). The idea that human actions correspond to events (an idea only evoked in this text and defended in [24]) seems to us to be a sufficient argument.

In conclusion of this chapter, and to express the general principles of our ontology of the entities 'occurrences', we will add two slogans to that of Guarino: (1) 'Let's substantiate physical processes!', so as to grant them the same mode of endurance as physical objects, and (2) 'Let's abstract events!', to give them the possibility to *occur* in addition to that of *existing*.

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