



## Everything Flows: Towards a Processual Philosophy of Biology

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## Processes and Precipitates

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### Abstract and Keywords

Biology is about things: organisms, but also about the processes in which they and their parts are involved as participants—reproduction, growth, respiration, hibernation, migration, interaction, selection, adaptation, evolution. The deeper one goes, the more these processes seem to matter—processes such as mitosis, meiosis, catabolism, anabolism, and so on. Yet at each stage we are confronted with the same dichotomy between things and the processes in which they are involved, down to molecules and their reactions. Is it possible to conceptualize a metaphysically superior revisionist biology in which everything basic is processual, without losing touch with the things of standard biological discourse? This chapter argues that it is, by understanding continuant things as precipitates of processes and thus by construing the whole organic sphere as *au fond* processual.

*Keywords:* abstraction continuant, genidentity, occurrent, process

*Ordinary men live so completely within the house of the Stagyrte that whatever they see out of the windows appears to them incomprehensible and metaphysical.*

—C. S. Peirce (2000: 168)

### 1. Introduction

In this chapter I note the pervasive distinction among objects in time, including all objects of interest to biology, between continuants or substance-like entities on the one hand and occurrents or process-like entities on the other. I shall

endeavour to make the distinction a little more precise, and argue for the distinctness and real existence of objects of both sorts, while upholding the metaphysical priority of processes. The nature of the relationship between the two sorts turns on a type of causal relationship known as ‘genidentity’, and the cognitive operation whereby we recognize continuants amid occurrents will be taken as a species of abstraction. The resulting metaphysics prioritizes processes over substances but does not throw substances out completely.

### 2. The Continuant/Occurrent Duality

There is a pervasive and basic duality in the way in which we speak about objects in the real (spatio-temporal-causal) world. Some things are in time in such a way that they grow through the accumulation of parts—*temporal parts*—as time goes by. These are events, processes, and states. The other sort of things are those traditionally called *substances*: people and other animals and organisms, houses, cars and other artefacts, mountains, rivers, planets and stars, and other natural objects. Unlike the other basic sort, they do not add temporal parts but are said to remain identical or the same at different times. It is the same person, cat, car, or river it was yesterday, notwithstanding changes to it in the meantime. I propose in this chapter to use the terminology invented by W. E. Johnson a century ago<sup>1</sup> and call the second **(p.50)** group *continuants* and the first group *occurrents* (as in Simons 1987: 118 *et passim*). More recently the terms ‘endurant’ and ‘perdurant’ have been used for continuants and occurrents respectively (Lewis 1986: 203 ff.). These have two disadvantages: they are very alike and initially confusing, and they postdate Johnson’s coinages by several decades.

*Prima facie* examples of continuants are legion: organisms like ourselves, animals, plants and so on, artefacts like houses, chairs, and ships, geographical features like lakes and valleys, astronomical objects like stars and planets, are all continuants in this sense. For present purposes, the most important types of occurrent are processes. Examples of processes are breathing, growing, flowing, cooling, contracting, singing, and orbiting. Both living and non-living continuants engage in or are involved in or participate in processes and may have processes going on in them. There is one borderline case of objects in time where the continuant/occurrent duality breaks down, and that is for instantaneous objects, which by definition lack temporal parts. I shall not be concerned with such cases.

The continuant/occurrent duality is firmly anchored in our ways of thinking and speaking. Continuants are typically designated by nouns, while occurrents are typically indicated by verbs. The *American Heritage Dictionary* indeed defines a verb as ‘[t]he part of speech that expresses existence, action, or occurrence in most languages’. The noun/verb distinction was recognized as such by Plato and Aristotle and is universal in human languages. I said that verbs *indicate* occurrents rather than designating or denoting them, because a verb in use

predicates rather than names: in 'John is breathing' only the subject term denotes, while the predicate says something of or predicates something of John. If we wish to talk *about* an occurrent, we typically nominalize a verb and form a derivative noun or noun phrase: *John's snoring last night*, *Luciano's rendering of 'Nessun dorma' in Madison Square Garden in 1987*, *Vesuvius's eruption in AD 79* all designate occurrents. We are extremely adept at coining and using such nominalizations in both impromptu and routine ways.

### 3. Specification

David Lewis introduced his distinction between enduring (said of continuants) and perduring (said of occurrents) as one among entities all of which *persist*, that is, exist in time and last from one time to some later times. I shall use the word 'persist' in this neutral way.

A *persistent* is an entity that exists in space and time, exists for—or at—more than an instant (and so persists), and at any time at which it exists has a spatial location. Its locations at the times at which it exists sum to a spatio-temporal region that I call its *locus*. For it to be a persistent, there must be parts of its locus that are in time-like separation.<sup>2</sup>

An *occurrent* (perdurant) is a persistent that has disjoint parts that are in time-like separation, such that, at a given time when it exists, there is a maximal part of it, all of **(p.51)** whose parts exist wholly within that time, so that such maximal parts for disjoint times are disjoint. These are called *temporal parts* of the occurrent. In the limiting case, the time is an instant and the temporal part is called a *phase* or an instantaneous time slice of the occurrent.

A *continuant* (endurant) is a persistent such that, at any instant at which it exists, it is identical with the maximal part of it. Hence, at different instants at which it exists, its maximal parts that exist are identical with one another and with it. By this characterization, a continuant cannot have temporal parts, since an occurrent's maximal parts for distinct instants are disjoint and so not identical, whereas a continuant's maximal parts at distinct instants are it, and so are identical. It further follows that a continuant may have a part at one instant that it does not have at another.

We assume that the non-instantaneous temporal parts of occurrents are themselves occurrents and the parts that a continuant has for a time are themselves continuants. In other words, the formal property of being a continuant or an occurrent is *dissective* (see Leonard and Goodman 1940: 55) or propagates down to parts, instantaneous parts excepted.

Persistents are usually not wholly static but vary with time: a plant grows from a seedling into a mighty tree; the net flow of water in a tidal river is now upstream, now downstream. When a continuant varies in such a way, we say that it changes: it has first one characteristic, then later another characteristic

incompatible with the first. The continuant itself is taken to survive the change. When an occurrent varies, we may ascribe the variation to differences of characteristics among its temporal parts: this part of the flow is upstream, that later part is downstream. The whole occurrent, of which these are temporal parts, inherits this variation from its parts in an analogous way to that in which a tiger's coat is variegated because different parts of it have different colours. In the case of a continuant, however, there are no temporal parts from which it can inherit the variation, so it is the continuant itself that changes. Strictly speaking, then, it is incorrect to say that an occurrent changes.<sup>3</sup>

Continuants and occurrents do not merely sit side by side in the metaphysical inventory: they are intimately involved with one another. When a leopard moves through the bush, its movement is an occurrent—as is its breathing, heart beating, tail flicking, and so on. These occurrents in turn involve other continuants: the heart, lungs, and tail of the leopard, the leaves and air molecules it brushes aside. The events and processes in which an organism or other continuant is involved throughout the time it exists constitute what we may call its *life*.<sup>4</sup> How the continuant and its life are related is something the metaphysical story of continuants and occurrents needs to make clear. Continuants and the occurrents in which they are involved seem in many cases to occupy the same spatio-temporal region, albeit in different ways. Again, this is something that needs explaining (see Simons 2014).

#### **(p.52)** 4. The Priority Question

In the history of philosophy there have been those who regarded continuants as metaphysically more basic than occurrents, for example Democritus, Plato, Aristotle, Aquinas, Descartes, Kant, Brentano, Geach, Strawson and modern neo-Aristotelians such as Jonathan Lowe. They have generally held the basic things to be substances, and in western philosophy they have been the majority. They take processes and events to be changes in or among substances or other continuants. On the other side are those, a minority, who regard processes as more basic than substances, for example Heraclitus, Bergson, Whitehead, Rescher, and Dupré. Occasionally philosophers treat both sides of the duality as equally basic, as does David Wiggins. After many years as a Wigginsian dualist, I now side with those who believe in the primacy of processes.

The metaphysical dispute between three-dimensionalism (endurantism) and four-dimensionalism (perdurantism) is partly skew to the question of priority. Endurantists believe that continuants are (typically) three-dimensional and lack temporal parts. Perdurantists on the contrary believe either that they have temporal parts and are extended in time (worm theory) or that they are instantaneous but stack up in succession (stage theory) (see Sider 2001; Hawley 2001). Continuants, as we conceive and think of them, lack temporal parts, and this is reflected in our explication in the previous section. For this reason, those perdurantists who say that organisms, artefacts, and so on *are* processes are

best interpreted as saying that what we *thought* were continuants are in fact occurrents: that, contrary to what we might think, people, cats, trees, and mountains do have temporal parts. Whether they are metaphysically prior to, posterior to, or coeval with perdurants is a different issue. I hold that both continuants and occurrents exist and are differentiated as outlined, but that occurrents, processes foremost, are metaphysically prior.

So, total scepticism aside, there appear to be five possible metaphysical positions with regard to continuants and occurrents and which ones are basic. Here they are, with some recent representatives:

- (a) There are only continuants: Brentano (1981).
- (b) There are only occurrents and no continuants: Lewis (1986), Seibt (2004),<sup>5</sup> Baptiste and Dupré (2013).
- (c) There are both and continuants are prior: Strawson (1959),<sup>6</sup> Lowe (1998).<sup>7</sup>
- (d) There are both and they are equally basic: Wiggins (2001).
- (e) There are both and occurrents are prior: Whitehead (1978), Rescher (2001), Simons.

**(p.53)** From here on I shall overlook the distinction between events and processes and describe all occurrents as ‘processes’. This allows me to smooth out what would otherwise be a small but irritating wrinkle in the history. The man widely (and correctly) regarded as the foremost modern process metaphysician, namely Alfred North Whitehead, did not in fact use the term ‘process’ as I use it, for a worldly denizen extended in time (see Simons 2015). For Whitehead, somewhat ironically, ‘process’, as in the title of the *chef d’oeuvre* of process philosophy, *Process and Reality*, stands for what he calls the ‘concrecence’ or becoming of an individual event; something he (again misleadingly) calls *genetic division*. This, he states explicitly, does not unfold or occur in time (Whitehead 1978: 238). The events themselves, which in his middle philosophy all have proper parts but in his later philosophy have no proper parts at all, are therefore atomic and are redubbed ‘actual occasions’. They are in time but do not unfold, since they are atomic, even though they occupy or ‘enjoy’ a small extended quantum of space–time that comes into existence with them. The mereological analysis of regions is called by contrast *coordinate division*. This dualism of Whitehead’s is unnecessary and obfuscating. By calling Whitehead’s atomic events and the bigger ensembles they compose ‘processes’, we are able to continue describing him straightforwardly as a process metaphysician, and we can then safely ignore the mysterious non-temporal becoming what he called ‘process’. Whether there are or are not atomic events as Whitehead thought can be left aside here. If there are, then processes in the standard sense are composed of such events and are causally strongly connected parts of the four-dimensional tapestry of occurrence.

### 5. Reasons to Take Processes as Fundamental

As common sense is only the vestibule to serious metaphysics, we cannot rest on it except as offering data to be properly explained and accounted for.

Nevertheless, there are solid scientific and metaphysical reasons to be confident that processes not only exist but are more fundamental than substances or other continuants.

In science, processes of various kinds figure ineliminably: in relativity theory, emission, propagation, and absorption of electromagnetic radiation; in quantum theory, exchange of force-carrying bosons; in both, fluctuations in field values. Astronomy deals with star formation, evolution, and death, the formation of planetary systems, the rotation of galaxies, the occurrence of supernovae and gamma radiation bursts. Geology deals with tectonic plate movement, formation and erosion of mountains, precipitation, river capture, soil formation, earthquakes, and much more. The list can be extended indefinitely; I will mention some biological processes below.

Metaphysically, we need truth makers for propositions stating the existence of a continuant *at a time*. Truth makers have to necessitate what they make true. Both Wellington and Napoleon existed on 18 June 1815, but neither of them *necessitated* his own existence on this date, since either could have died earlier.<sup>8</sup> What necessitates the existence of Wellington and Napoleon on that day is the occurrence of the vital processes in virtue of which each of them was alive then (see Simons 2000b).

**(p.54)** As Ramsey (1927) sketched and Davidson (1967) later spelled out more clearly, many event and action predications are covert existential quantifications over individual events, any of which will serve to make the predication true. ‘John drank coffee yesterday’ may be true no matter how often John drank coffee yesterday, provided that at least one event (or episode) of John’s drinking coffee occurred yesterday.

Not all objects occupy space and time in the same way—obviously, since occurrents are, but continuants are not, extended in time. Maybe universals such as being a dog or having a mass of 1 kg are numerically the same at all places and times at which they are instantiated. To make sense of the variety of occupation relations whereby *A* occupies location *L*—extensively or intensively—we best start with one form of occupation out of which all the others can be derived by abstraction. This is the mode in which processes occupy spatio-temporal regions by being spread out across them (see Simons 2014). Note that this does not analytically entail that any process has a part corresponding to every subregion of the region it occupies: I leave open the possibility of extended simples.

Finally, and this is perhaps the most important reason, processes are causal. It is not that they have causal powers like a coiled spring: they do actually cause things to happen. Causation is arguably fundamental and irreducible: it is, as Mackie (1980) nicely termed it, the cement of the universe. We therefore need terms of causation, and these are events and processes. This also allows for a causal theory of time, one not relying on modality. There is time because stuff happens, and time is directional (at least above a certain granularity) because the causation that makes stuff happen and moves processes along is irreversible.

Causation or determination is that relational factor or species of relational factor in virtue of which one process (partly or wholly) determines or affects the probability that another process occurs. We allow partial as well as total causes, in case some events occur spontaneously or partly spontaneously. We allow negative as well as positive influence: a positive cause compels or inclines something else to happen (increases its probability, to 1 if compelling). A negative cause prevents or inhibits something from happening (decreases its probability, to 0 if preventing). Causation is not necessarily deterministic: we need to allow for uncaused (spontaneous) or partly caused processes.

Causation is called a *factor* because we do not want to posit an additional item called a causal *relation* over and above the processes. To do so would be to invite a regress: what caused the cause to cause its effect? No: processes happen. Some are caused by others, singly or in concert, determinately or inclinationally.

### 6. (Just a Few) Kinds of Processes in Biology

Biology seems at first sight to be primarily about continuants: organisms and their parts (hence anatomy). It is, however, also replete with talk about processes and their parts, because what makes the difference between living and non-living things is their vital processes, at all levels of organization. There is the molecular level: the intricate workings of cell biochemistry—that is, metabolism—through the cell life cycle, mitosis, meiosis, differentiation, and apoptosis. Then there is the complex physiology of multicellular organisms: respiration, digestion, circulation, movement (**p.55**) and other behaviours, growth, and maturation. There is also symbiosis, birth, disease, and death. And there is the tapestry of events at the level of populations: adaptation, speciation, evolution, extinction, and so on.

### 7. Continuants out of Processes

If processes are prior to continuants, in what does their priority and the derivativeness of continuants consist, and how are they related? There is a story to be told, and since the categories of continuant and process are extremely general, it has to be extremely general too. Continuants, according to my view (Simons 2000a), are to be understood as invariant *precipitates* of a species of causal relatedness known, after Lewin (1922), as *genidentity*.<sup>9</sup> Genidentity pertains to the vital processes of a continuant—those in virtue of which it exists

and continues to do so (this has a causal component). These processes have phases that succeed one another and, when things are going standardly, do so in an orderly way. In this context, 'orderly' means that genidentity as a relation between process phases is symmetric and transitive, so an equivalence relation. Whitehead, less illuminatingly, refers to 'social order' and 'personal order' among events, which allow us to recognize a continuant constituted by them (Whitehead 1978: 34). But while the means by which we gain cognitive access to continuants, recognizing them as the same in their successive appearances, may be termed a species of abstraction, it does not follow that continuants are abstract entities in the standard sense of being outside space, time, and the causal order. On the contrary, many physical continuants such as those instanced before are among the most paradigmatically real and concrete things in the world we experience. They have causal powers, even though they are not themselves causes. The stone against which I stub a toe cannot be faulted for concreteness; it is precisely because the event of my toe's colliding with it causes pain that I am acutely aware of it as a very solid physical body. For that reason, I prefer to say that continuants are not abstracted from processes but are rather *precipitates* of processes: they are what abides, as certain kinds of processes continue and develop.

If it is correct that there are no continuants without genidentity among certain process phases, then that explains the priority of processes. Continuants supervene on processes, though not all processes constitute or precipitate continuants. A dissipative process such as an explosion does not, since it lacks the relative stability required for a continuant. Even here, though, there may be continuants associated with the process. A physical wave such as a water wave, a sound wave, or, thinking of the explosion case, a shock wave is a continuant, not a process, since it may move and change. A water wave can travel long distances, but the material substratum—the water—in which it exists does not travel like this, but only moves locally and briefly. But, unlike more familiar substance-like material continuants, a wave typically propagates and migrates through successive material substrata. That gives it priority. The exact nature of the relationship between continuants and their vital processes **(p.56)** apart from the fact of priority requires more consideration, however, and that is why we must look at abstraction in more detail.

### 8. Abstraction

Abstraction is a species of cognitive operation carried out by us, and probably also to some extent by animals of other species. It is very common and underlies a significant portion of sophisticated linguistic and scientific practice. Having given more detailed accounts of abstraction elsewhere (Simons 1981; 1990; 2012),<sup>10</sup> in this section I will focus on an example to illustrate abstraction at work, and in the next section I will apply the idea to processes.



I start from a given domain of objects, which are often called the *concreta*. Among these a special kind of relation applies: relations that constitute exact similarities in some respect. For example, suppose our *concreta* are people and the relation is *weighs as much as* (say, to the nearest 10 g, rounded down). This relation has the following logical properties: everyone weighs as much as him- or herself; and, if two people each weigh as much as a third, then they weigh as much as each other. When people weigh as much as each other, we say they have the same *weight*, and these weights are not concrete but abstract, they are the *abstracta*. The transition from saying that  $x$  weighs as much as  $y$  to saying that  $x$ 's weight is the same as  $y$ 's is typical, and so commonplace we hardly notice it.

Here are a few samples of such transitions from different areas, where the domain is named, the *concreta* are mentioned in a relational statement to the left of the double arrow, and the *abstracta* are named in the identity statement to the right of the double arrow:

- (i) People on a given date:  $x$  is as tall as  $y \Rightarrow$  the height of  $x =$  the height of  $y$
- (ii) Straight lines in space:  $x$  is parallel to  $y \Rightarrow$  the direction of  $x =$  the direction of  $y$
- (iii) Bodies:  $x$  is as massive as  $y \Rightarrow$  the mass of  $x =$  the mass of  $y$
- (iv) Collections: there are as many  $a$  as there are  $b \Rightarrow$  the number of  $a =$  the number of  $b$
- (v) People:  $x$  earns as much in a year as  $y \Rightarrow$  the annual income of  $x =$  the annual income of  $y$

Relations with the logical properties that sustain such transitions are called equivalence relations, and they typically introduce new abstract terms on the right-hand side, hence the term *abstraction*. Frege described abstraction transitions as 'recarving the content' of the sentences (Frege 1951: § 64). Though in the end he preferred a different way to work with *abstracta*, we shall stay with abstraction transitions.

On their own, these do not get us very far. However, when properties and relations can be found that are *invariant* under the equivalence in that any items equivalent to items having the property or relation themselves have the property or relation, **(p.57)** then a vocabulary can be built up to deal with the *abstracta* without necessarily mentioning their concrete basis. For example, *is heavier than* is invariant under *weighs as much as*, so

Jules is heavier than Jim  $\Leftrightarrow$  Jules's weight is greater than Jim's

Jules is 70 times heavier than the standard kilogram  $\Leftrightarrow$  Jules's weight = 70 kg

It is important that, when we move from the left to the right, there is a shift in sense: Jules's *weight* is not heavier than Jim's, it is Jules who is heavier than Jim; his weight is *greater* than Jim's. And while Jules *weighs* 70 kg, his weight does not weigh anything: it *is* 70 kg. This sense adjustment will be important below. As the example suggests, abstraction and invariance are at the basis of many of those measurable characteristics we call *quantities*.

### 9. Abstracting to Continuants

Consider now the genidentity relation on process phases (temporal parts of processes or process complexes). Then

Processes and their phases:  $x$  is genidentical to  $y \Leftrightarrow$  the continuant of  $x =$  the continuant of  $y$

This abstracts from particular spatio-temporal location: different genidentical phases will have different temporal locations and may have different spatial locations. But this does not take continuants out of space and time, because, defining

for all processes  $x$  and  $y$ :  $x$  is a temporal part of  $y \text{ =Df. } x$  is a part of  $y$  and any part of  $y$  that exists only when  $x$  exists is a part of  $x$

and,

if  $x$  is genidentical to  $y$ , then the continuant of  $x$  (and  $y$ ) exists when  $x$  exists and when  $y$  exists, and only exists when some  $z$  exists such that  $z$  is genidentical to  $x$ .

A continuant exists when and only when its constitutive processes are going on. Since a non-instantaneous process has disjoint temporal parts, any process constituting a continuant has parts that exist at some times and not others during the course of the whole process. For example, being a Tuesday part (when the process is not confined to Tuesday) is not invariant under genidentity. Therefore continuants do not and cannot have temporal parts, even though their lives are limited by the temporal extent of their constitutive processes.

We can likewise define the spatial location of a continuant at a time as the spatial component of that temporal part of its constitutive processes. In general, and relativizing suitably, a continuant's spatial location will be different at different times. In popular parlance, it will *move*. More generally, if a property or relation of a process that constitutes a continuant is not invariant under genidentity, then the adjusted property or relation will not belong to the continuant. If the property is one of a temporal part of the process, we may ascribe the adjusted property to the continuant only by relativizing or indexing it to the time in question. This is why 'at  $t$ ' locutions are needed for continuants; and it helps to explain what their changing consists in.

**(p.58)** Finally, a continuant is causally involved insofar as its constitutive processes and their parts are causes and effects of other processes that are not parts of its constitutive processes. So, while physical continuants are supervenient derivative precipitates, they are not abstract entities.

### 10. Modal Properties

Occurrents are subject to mereological and locational essentialism, that is, where and when they are and what their parts are is all essential to them. This cannot be argued here, but it is metaphysically advantageous because it supports a causal theory of time. Modal identity conditions for continuants, however, are considerably more flexible than those of their actual, constituting processes: their location, lifespan, properties, and relations are much more subject to accident and contingency because their dependence on their constituting processes is generic rather than rigid.<sup>11</sup> So they support genuine transworld identity, whereas when we talk about an occurrent using a non-rigid definite description, such as ‘the Battle of Waterloo’, to the extent that we allow for contingency, we are talking about counterparts.

### 11. Consequences for Biology

Organisms, as well as their parts and collectives, are metaphysically secondary to the processes that constitute and sustain them. This means *you*, both as a continuant human organism and (even more dramatically) as a person. Humans require sustaining vital processes in order to exist, but in certain pathological cases these are insufficient to sustain personhood, which is a far more fragile status than merely being alive. Neonates, comatose humans, and highly senile humans are not, then, persons (sometimes they are temporarily, sometimes not).

Since the natural grain of our language is towards talking about continuants, we need to work on developing vocabulary, metrics, and data representations for processes, their parts, their features, their relations, and their quantities.<sup>12</sup> Because of this natural grain, we cannot jettison our dualistic vocabulary without loss of information and intelligibility, so it is quite right to carry on talking as now and to design biological and medical databases with dualistic vocabulary.<sup>13</sup> Nevertheless, apart from continuously reminding ourselves of the metaphysical priority of processes, it is good to learn to think more in process terms and to reduce our dependence on the Aristotelian heritage.

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### Notes:

<sup>(1)</sup> Johnson first used the term 'continuant' in print in Moore et al. 1916: 431. 'Occurrent' as contrasted with 'continuant' occurs in Johnson 1921: 199, but was in frequent use as a synonym for 'event' or 'occurrence' in the sixteenth and seventeenth centuries.

<sup>(2)</sup> An entity, all of whose sub-loci are in space-like separation from one another, can be taken to exist instantaneously in some reference frame, and so not to persist from one time to a later time in that frame.

<sup>(3)</sup> See Dretske 1967. Dretske's point applies more widely to all variation, not just to motion.

<sup>(4)</sup> In this special sense, inorganic continuants like rivers and stars also have lives. If this terminology is felt to be unacceptable, another term, such as 'history', could be employed, though this is then ambiguous between events and the description thereof.

<sup>(5)</sup> Seibt is perhaps the most radical contemporary process metaphysician, envisaging as she does a category of general processes that rejects even the endurance/perdurance distinction, as well as the particular/universal distinction: see Seibt 2008 and chapter 6 here.

<sup>(6)</sup> Strawson (1959) treats bodies as 'basic particulars' and events as secondary. Strictly, however, the asymmetry Strawson detects is one of reference and epistemology rather than metaphysics. Bodily substances could be referentially basic and still be ontologically derivative.

<sup>(7)</sup> For Lowe, substances are continuants and other things are identity-dependent on substances, but substances are (by definition) not identity-dependent on anything else.

<sup>(8)</sup> By contrast, each makes true his own absolute, *untensed* existence statement.

<sup>(9)</sup> The concept of genidentity is also examined in chapters 4, 5, 7, and 11.

<sup>(10)</sup> The theory of abstraction follows precedents in Weyl (1949), Lorenzen (1962), and Dummett (1973).

<sup>(11)</sup> For the distinction between strong (rigid) and weak (generic) dependence, see ch. 8 in Simons 1987.

<sup>(12)</sup> This extends even to metrology. The SI unit of mass, the kilogram, is currently defined in terms of a body, a platinum-iridium sphere in Sèvres,

France. Proposals for a revision basing the kilogram on Planck's constant, whose units are Joule seconds, the unit of action, are therefore a welcome step in the direction of a dynamic, process-based metrology.

(<sup>13</sup>) As advocated by Grenon and Smith 2004 and implemented in basic formal ontology (BFO): see Arp et al. 2015.

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