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(Denkel 1996, 208) The identity of living beings allows for far more alterations than the identity of artefacts. But, in order to maintain their identity, they have to fall under the same sortal-token.

Living beings may have disproportionate growth, loose some parts of their body, which may become dysfunctional, they may even generate altogether new parts for the individual. But even in these cases they would maintain the same sortal token as long as they live. The sortal, however, indicates limits of change beyond which the form-token will be lost.

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Beyond Endurance and Perdurance: Recurrent Dynamics

JOHANNA SEIBT, Aarhus

1. Introduction

During the last decades the so-called ‘problem of persistence’ has been continuously—persistently, one is tempted to say—in the focus of the research debate in analytical ontology. There are impressive advances in finessing positions and arguments, but essentially the debate seems caught in a deadlock between, on the one hand, identity-based accounts suitable for the ontological interpretation of common sense (but not science), and, on the other hand, relation-based accounts suitable for the ontological interpretation of science (but not common sense). Since in philosophy a theoretical impasse of this kind is commonly generated by a joint implicit assumption, one might try to step out of the debate, identify questionable presuppositions, and approach the topic with fresh eyes. This is the task of this paper.

In fact, as it appears, participants of the debate about persistence share not only one problematic assumption, but overlapping parts of an entire network of presuppositions. Elsewhere I have shown this network of presuppositions to be operative not only in the debate about transtemporal identity (‘persistence’), but also in the discussion of numerical identity (‘individuation’) and qualitative identity (the debate about ‘universals’). As I have argued, these presuppositions delimitate a research paradigm that has informed the ontological discussion from Aristotle to the present day, the ‘substance paradigm.’¹

Ontological presuppositions are hidden axioms of inquiry that in most cases cannot be shown to be false in any straightforward sense. At best one can show that certain theoretical set-ups in ontology are not well suited to fulfilling their explanatory tasks. In fact, the presuppositions of the substance paradigm that drive the debate about persistence present a particularly striking case in this regard—they make it particularly difficult to devise a coherent ontological interpretation of persistence and change

¹ Seibt 1990; 1996 a,b,c; 2005.

while taking the 'logic' (inferential role) of our statements about persistence and change at face value.

Fortunately the presuppositions of the substance paradigm are by no means 'laws of thought' but a matter of theoretical habituation only. We can give up on the substance paradigm, on any and even on all of its constitutive presuppositions, and adopt new principles of theory construction in ontology. The theoretical choices in analytical ontology are more variegated than the current debate suggests.

The purpose of this paper is to introduce the reader to a new account of persistence developed within such a new ontological framework, General Process Theory (GPT), based on a new ontological category or type of entities called *general processes*, or, less 'technically,' *dynamics*. Unlike other attempts to promote process-based descriptive frameworks, GPT is firmly committed to the methodology of analytical ontology. Within GPT persistence is *the strict identity or sameness in time of an entity that occupies a spatiotemporally extended region*. Thus the new account straddles the traditional juncture between endurance and perdurance theories, but in the sense of leaving both of them behind, since it operates with a different notion of individuality that is not tied to particularity (i.e., necessary unique locatedness). To motivate the new approach I begin by highlighting some of the presuppositions that constrain the solution space for the 'problem of persistence' in questionable ways. Then I offer a sketch of the core ideas of General Process Theory, and finally I adumbrate how ontological counterparts ('truth-makers') for assertions about persistence and change can be formulated within this framework, highlighting some of advantages vis-à-vis extant endurance and perdurance accounts.

2. The problem of persistence

Contemporary analytical ontology follows a general methodology that can be reconstructed as follows. An ontology is a theory of truth-makers for the sentences of a certain natural or scientific language L .² An ontology

² The term 'truth-maker,' originating from Husserl, has been brought again into currency by Mulligan/Simons/Smith (1984). A 'truth-maker' is any kind of entity "in virtue of which sentences and/or propositions are true" (ibid. 287), e.g. objects, properties, events, state of affairs; truth-makers contrast with 'truth-bearers,' which are any kind of entity which 'has' the properties of being true or false, e.g., a sentence or proposition. As I use the term, the truth-maker of a sentence p is described by the right-hand side of the Tarski-biconditional for p , where p is a logically atomic

describes what there is in the world-of- L -speakers—i.e., in the world as speakers of L do or can conceive of it—that makes the true sentences of L true. The structural descriptions of truth-makers provide explanations for why L -speakers may justifiedly draw certain, highly general, 'material'—call them 'categorical'—inferences. For instance, an ontological theory aims to explain, by means of a structural description of a truth-maker, why speakers of common sense English are entitled to infer from the true sentence 'this tree is tall' that the denotation of 'tall' but not the denotation of 'this tree' may occur multiply in space, while this is not so for the denotation of 'this tree.' An ontology thus provides structural descriptions of the domain of a language L in terms of which truth-makers for atomic L -sentences are defined that can justify the categorical inferential role of these sentences—or even more briefly, an ontology is an explanatory theory of the categorical inferences licensed within a certain language L .³

Ontological investigations of persistence are typically focused on the interpretation of statements about the existence of *things* in time, i.e., assertions about change and sameness such as:

[1.] The Statue of Liberty was first copper-colored, but turned green over the course of the years.

[2.] The statue you see now is the same as the statue that was being dedicated in 1886.

One may suspect that the traditional focus onto things amounts to a problematic heuristic restriction, and below it shall become clear that this is indeed so. But since things do play an important (if arguably not primary) role in our interaction with the world, ontological concern with the persistence of things can easily be motivated. In fact, the successful interpretation of statements about the persistence of things (and persons) might well be considered a necessary condition for the acceptability of any ontological framework, or so I shall assume in the following.

Statements like [1] and [2] invite philosophical puzzlement. A statement about change like [1] seems to assert that some thing is different now from the one it was then, and yet is the same one thing. A statement

sentence or proposition; negated or logically complex sentences do not have truth-makers.

³ More precisely, the categorical inferences explained by an ontology are typically licensed not by one single language but by a class of *intertranslatable* languages, i.e., by a conceptual scheme in Wilfrid Sellars' sense. For a detailed characterization of the methodology of ontology as "theory of categorical inference" see Seibt 2004, part 1, where I also explain why and in which sense ontological theories are metaphysically neutral.

about sameness in time like [2] seems to assert that what appears to be 'two things'—the statue that was dedicated in the past and the statue you are looking at now—somehow are nevertheless one and the same thing. The task of an ontological theory of persistence of things is to remove these apparent tensions. As a first step one might distinguish between two senses of 'sameness': 'qualitative identity' versus 'numerical identity'. An assertion about change, as in [1], states a difference that pertains merely to the features of a thing, to its qualitative identity, while the numerical identity of that which said to change remains unaffected. Similarly, an assertion about sameness in time as in [2] is a claim about numerical identity of something referred to with two definite descriptions highlighting differences in qualitative identity only.

However, this first step of ontological analysis leads into trouble as soon as the concepts of numerical and qualitative identity are definitionally connected, as postulated in Leibniz' "principle of the indiscernibility of identicals", in standard systems of predicate logic known as "the Leibniz Law". The basic problem for an ontological account of the persistence of things thus is frequently stated in terms of the incompatibility of the following principles:

(Endurance: Persistence is identity)

If a thing α is said to persist through the temporal interval from t_1 to t_2 , then α as it exists at t_1 is numerically identical with α as it exists at t_2 , (and the same holds for all intervening points in time).

(P1: State analysis of change)

Change is the qualitative difference of particulars. That is, if a thing α is said to change during the temporal interval from t_1 to t_2 , then α as it exists at t_1 is qualitatively different from α as it exists at t_2 . In other words, predicates that truly apply to α as it exists at t_1 do not apply to α as it exists at t_2 , and vice versa.

(Leibniz Law: numerical identity implies qualitative identity)

If two names or definite descriptions 'A' and 'B' denote one thing, i.e., if the denotations of 'A' and 'B' are numerically identical, then all predicates true of the denotation of 'A' are true of the denotation of 'B'.

Reversing it by contraposition, the Leibniz Law says that qualitative difference implies numerical difference: if different predicates can be truly

applied to the denotations of some two names or definite descriptions, these cannot denote one entity.

The difficulty is by now so familiar that participants in the debate about persistence are content quickly to gesture towards (P1) through (P3) before proceeding to the discussion of a solution strategy. However, upon closer analysis the three principles are in conflict only if they are combined with the following principles, which are commonly not mentioned but presupposed:

(P2: The subjects of changes persist)

If a thing α persists through a change C, then that to which we attribute persistence is the same entity as that to which we attribute change.

In other words, (P2) ensures that when we assert of the statue in [1] that it has changed, and in [2] that it has persisted, the grammatical subjects of these two statements denote one and the same entity. Thus with (P2) we cannot say that what is said to persist is numerically identical in time while what is said to have changed is not. Moreover, with some exceptions, participants in the debate quietly assume that numerical identity is not something an entity could lose or gain over time:

(P3: Numerical identity is temporally non-variant)

Numerical identity is a relation that applies both at and across time; but it is not relative to time.⁴

This principle rules out the possibility that the numerical identity of an entity might change over time, such that at times two denotations of names for things might be said to be identical but not at other times. More importantly, it undermines the two most straightforward strategies of eliminating the conflict between the endurance interpretation of persistence, the Leibniz Law, and (P1), the state analysis of change. The first strategy is to restrict the Leibniz Law to judgments about numerical

⁴ Some authors discuss the question of "temporary identity" but this pertains to the temporary identity of items that are traced under *different* sortal concepts, such as the temporary identity of a statue-shaped item and a lump of clay (cf. e.g. Gallois 1990). In contrast, (P3) is a principle about numerical identity under one sortal concept—it says that if some x is one F then this holds for all times at which x exists. Note also that a more precise formulation of (P3) should formulate identity as coreference rather than as a relation (two names or definite descriptions denote one and the same entity).

identity *at a time*. But given (P3) it would be an odd move indeed to claim that even though numerical identity *at a time* and numerical identity *across time* are the same relation, the axiomatic characterization of that relationship afforded by the Leibniz Law, the *only* distinctive axiom of identity we have in logic, does not apply to all of its instances. The second strategy consists in restricting the quantification within the Leibniz Law to predicates denoting the *essential* features of an entity. This restriction makes—*prima facie* at least—good sense for numerical identity *across time*: an entity persisting through a change can be said to retain all its *essential* features, while the change pertains to contingent features. But then the Leibniz Law could no longer, by itself, serve as an axiomatic characterization of numerical identity *at a time*, for it would allow for one and the same entity to have contradictory contingent features at the same time. The obvious remedy of adding an axiom for numerical identity *at a time* would amount to a diversification of numerical identity, which is discouraged by presupposition (P3). In sum, in so far as participants in the debate about persistence have felt a more profound tension between the first principles listed above, this must be attributed to implicit commitments to presuppositions (P2) and (P3).

In combination the five principles just considered generate what one might call the 'basic apory of persistence', a constellation of incompatible yet *prima facie* plausible tenets. The basic task for a theory of persistence thus consists in deciding whether the initial conflict between these principles can be removed by reinterpreting one of the principles or, alternatively, which one(s) of the conflicting principles ought to be rejected. These two options coincide with the main juncture in contemporary approaches to persistence.

So-called 'endurantists' hold on to the thesis that persistence is numerical identity but insists on a clear analysis of temporal predications. Once these are in place, so runs the argument, statements about an entity's changing are no longer generating any difficulty for the identity reading of persistence. For example, endurantists have suggested that the predicates in terms of which we describe a change ("was green but is now red") denote time-indexed features:

A 'complete' property of an individual is a compound temporalized (or dated) property, like *being green in August 1965* or *being born in 1769*,

and there is no question of an individual changing in the sense of once having and later lacking these compound properties.⁵

Since the thing that is said to persist through a change has *all* of its time-indexed properties at all times of its existence, persistence can be interpreted as numerical identity *across times* without getting into conflict with the (unrestricted) Leibniz Law. The only difficulty with this move is that to the extent to which it succeeds in 'rescuing' identity, it fails in preserving the phenomenon of change. We might try and say that change is a matter of time-indexed properties 'manifesting' itself at certain times but not at others—a leaf's *being green on August 8* is manifest exactly on August 8 while it's *being red on September 24* is manifest exactly on September 24, and so on. But such second-order properties of *being manifest at t* surely should also be covered by the Leibniz Law and thus we are back at the original 'apory'.

To sacrifice change for the sake of the identity interpretation of persistence does not seem an attractive choice. A successful *ontological* account of persistence should preferably not have any *metaphysical* implications in the sense of declaring as false sentences about change or transtemporal difference that we take to be true. A successful account of persistence should have a way of explaining what is meant by a true sentence like [1] which says that the properties of the denotation of 'the roof' at t_1 differ from the properties of the denotation of 'the roof' at t_2 .

Endurantists commonly—and often with surprising historical nonchalance—hold that the entities said to be numerically identical through time are "substances in the old sense",⁶ or postulate a category of "continuants" of concrete, particular 'thing-like' constituents that are the logical subjects of our predications. But there is no reason to believe that only thing-like ontological constituents could be numerically identical in time. Peter Simons has argued that within an ontology of tropes or property instances the traditional notion of a substratum can be refurbished in new and productive ways.⁷ On Simons' account things are ontologically constituted by a collection of tropes that can be divided into a "nucleus" and a "periphery". That which remains identical when a thing is said to change is a collection of tropes forming the "nucleus", while the "periphery" may at different times hold different tropes. Simons' trope-

⁵ Cf. Wilson 1956, 48.

⁶ Prior 1965, 63.

⁷ Cf. Simons 1994.

based endurantism most helpfully highlights that the linkage between substance ontology and endurantism is a matter of theoretical habit and not of conceptual necessity. However, to discharge its explanatory tasks, trope-based endurantism still owes us a clear account of the transtemporal identity of tropes themselves—if such property particulars are individuated by their spatiotemporal location, how could they ever move? Furthermore, given that the “nucleus” of trope bundle X is to contain all that which is essential to the thing associated with X, how should we account for essential *developments* in living things?⁸

The other main road out of the ‘apory of persistence’ is to deny that persistence is a matter of numerical identity, i.e., to reject the endurance view of persistence. Instead, so-called perdurantists claim that persistence is a mereological relationship: assertions like [1] and [2] above are made true by relations between the temporal parts of a fourdimensional entity. The terminological contrast between the endurance and the perdurance view of persistence goes back to Mark Johnston, but is commonly cited in D. Lewis’ pithy formulation.

[S]omething *persists* iff, somehow or other, it exists at various times; this is the neutral world. Something *perdures* iff it persists by having different temporal...stages at different times...it *endures* iff it persists by being wholly present at more than one time.⁹

Philosophers are attracted to the perdurance view and the ontology of so-called “fourdimensionalism”, since it derives its original motivation from the scientific description of natural happenings in special and general relativity theory as taking place in, or constituting, a fourdimensional structure of spacetime.¹⁰ Perdurantists differ, however, on the kind of conceptual adjustments that are to be made to the fourdimensionalist description of nature in relativity theory. For example, some perdurantist

⁸ Cf. Seibt 2005.

⁹ Lewis 1986, 202.

¹⁰ Note, though, while the compatibility with contemporary science certainly should count as an important asset, the ontological intimations contained in scientist’s so-called ‘instrumental glosses’ cannot be turned directly into an ontological theory. A fourdimensional manifold of point events fulfilling certain topological and metrical conditions might suit the interpretation of physics statements about idealized point-masses, but it does not as such lend itself to the ontological interpretation of common sense statements about the persistence of things through time and change.

have suggested that statements about change and persistence as in [1] and [2] above should be taken to be about fourdimensional wholes:

(“Hunk” View): The expression ‘the Statue of Liberty’ in sentence [1] denotes a fourdimensional entity L that has temporal parts l_1 and l_2 , standing in a relation R of temporal distance, and l_1 is copper-colored while l_2 is green. The definite descriptions in sentence [2], viz. ‘the statue you are seeing now’ and ‘the statue dedicated in 1886’ denote two different temporal parts l_i and l_j of L and state that these are temporal parts of L.¹¹

The three main difficulties arising for this suggestion come out most palpably in Quine’s early formulation of this version of fourdimensionalism:

A physical thing—whether a river or a human body or a stone—is...a sum of the temporally small parts which are *its* successive stages.¹²

If we identify things with their *de facto* spatial and temporal extension *sub specie eternitate*, i.e., with the material fillings of certain spatiotemporal regions, or with materially filled spatiotemporal regions, we are—in the first instance at least—committed to assuming that (a) all statements about things changing are analytic, (b) that the denotations of most names for things are inscrutable from the speaker’s point of view, and (c) that the predicates for things can be said to express properties of stages.¹³ The first two of these problematic commitments can be avoided once the dependence relations between temporal wholes and temporal parts are reversed. On the ‘hunk view’ the denotation of ‘the Statue of Liberty’, i.e., a fourdimensional whole (“hunk of matter”) is taken as basic; from this the notion of a stage or temporal part is derived, yielding denotations of temporally relativized definite descriptions such as ‘the statue you are looking at now’. In contrast, proponents of the so-called ‘stage view’ postulate as basic entities temporal stages, the denotations of temporally relativized definite descriptions, and then define the denotations of simple names such as ‘the Statue of Liberty’ in terms of sequences of such stages.

¹¹ Cf. Heller 1990.

¹² Quine 1952, 210; emphasis supplied.

¹³ Cf. Lewis 1988, 66: “When I sit and then stand, bent stages are followed by straight stages. Each stage has its shape simpliciter.”

(Stage View) The definite descriptions 'the statue you are looking at now' and 'the statue that was being dedicated in 1886' in sentence [2] denote stages s_1 and s_2 of a thing that has the essential properties P_1 of a statue, and there is a spatiotemporally continuous sequence S of stages all of which have the essential properties P_1 that connect s_1 and s_2 . Statement [1] says that there are two stages s_i and s_j in this sequence S that stand in temporal relation R , and s_i is copper-colored, while s_j is green.¹⁴

However, even though proponents of the stage view can dodge the mentioned problematic commitments (a) and (b), they still endorse assumption (c), namely, that predicates for things can be said to express properties of stages. As I will argue now, this assumption renders the stage view ultimately incoherent.

Let us first note that assumption (c) follows directly from presupposition (P1), the 'state analysis of change.' More carefully elaborated, (P1) combines actually two tenets: (i) the assumption that assertions about changes in things are best analyzed in terms of pairs of contrary or contradictory *properties exemplified by a particular*; and (ii) the assumption that that which is said to undergo change—the subject of the change—is the logical subject of the predicates in terms of which the change can be analyzed. In other words, whether championing the hunk view or the stage view, proponents of perdurantism are still committed to the idea that if the Statue of Liberty is said to turn green, and this change can be analyzed in terms of the properties of *being-copper-colored* and *being-green*, then at the beginning of this change there is a particular which exemplifies *being-copper-colored* and at the end of this change there is a particular (i.e., an entity that necessarily occurs at any time in one spatial location only) which is the logical subject of *being-green*. While endurantists subscribe to the state analysis of change in its strong reading: ' $\exists x(\text{at } t_1, F(x) \text{ and at } t_2 \neg F(x))$ ', perdurantist operate with the weaker reading: ' $\text{at } t_1, \exists x F(x) \text{ and at } t_2 \exists x \neg F(x)$ ', but in each case the variable ranges over a *particular* that can serve as the logical subject of the predicates (exemplify the properties) in terms of which the change is expressed (can be analyzed).

¹⁴ Cf. e.g. Hirsch 1982, Lewis 1983. More recently the "stage theory" has been contrasted—somewhat confusingly perhaps—with "perdurantism", as the combined thesis that (a) all temporal predications are about stages, but (b) only present stages exist, i.e., a tensed theory of time: cf. Hawley 2001.

The fact that perdurantists presuppose the core intuition of the traditional 'state analysis of change' generates a profound difficulty, however. For in order to render plausible the claim that those properties in terms of which we describe changes in *things* can be ascribed also to temporal parts, we need to assign to temporal parts temporal extension. Consider the following characterization of a 'stage'.

[A person stage] does many of the same things that a person does: it talks and walks and thinks, it has beliefs and desires, it has size and shape and location. ...[A person stage] even has temporal duration. But only a brief one for it does not last long. It begins to exist abruptly, and it abruptly ceases to exist soon after. Hence a stage cannot do everything that a person can do, for it cannot do those things that a person does over a longish interval.¹⁵

If temporal parts are momentary or temporally extended entities, they persist not only through time but also through change; in particular, a stage which "thinks" and "walks" certainly undergoes genuine alteration. But persistence through change is precisely the *explanandum* of the perdurance theory and thus should not appear in the *explanans*. Thus, in so far as stages are conceived of as proper candidates for logical subjects of predicates in terms of which we express changes in things, they must be taken to be temporally extended, in which case the perdurantist seems to be caught in a question-begging maneuver. On the other hand, if stages are taken to be instantaneous, almost none of the properties in terms of which we describe the change of a thing, could be ascribed to a stage (the only exception may be locational properties).

To throw the difficulty into sharper relief, consider the following central postulate of the stage view:

A sufficient condition for the succession S of object stages to correspond to states in the career of a single persisting object is that:

- (1) S is spatio-temporally continuous; and
- (2) S is qualitatively continuous; and
- (3) there is a sortal term F such that S is succession of F -stages.¹⁶

¹⁵ Lewis 1983, 76. The difference between thing stages and person stages does not matter in the context of the present argument.

¹⁶ Hirsch 1982, 36.

According to this postulate stages must have the same sortal properties of the things they compose – stages of a horse, a rose, or a rock must exemplify the properties of being a horse, a rose, or a rock. But being a horse, rose, or rock arguably takes a certain amount of time—it requires certain physiological, chemical, or quantum-physical processes. Thus the properties of *being-a-horse*, *being-a-rose*, and even *being-a-rock* cannot be exemplified by an instantaneous entity.

To be sure, one might, in analogy to the concept of 'speed at an instant,' derive from properties of things new properties for instantaneous entities. The latter would not be the properties corresponding to the predicates in terms of which the change is *described*, but they would be properties in terms of which the change in question can be *analyzed*. That is, one might postulate that stages $\langle s_i \rangle$ of a thing α all have properties $\{f_i\}$ such that for any property G of α , $G(\alpha) \leftrightarrow \langle f_i(s_i) \& \dots \& f_j(s_j) \rangle$. But while this strategy is open to the hunk view, proponents of the stage view cannot resort to it on pain of definitional circularity. As little as one can define a thing in terms of the sum of its temporal stages, one cannot define the properties of stages in terms of the properties of the entities (things) that are said to be ontologically composed of stages.

Whether endurantists and perdurantists can overcome the basic difficulties just adumbrated, remains to be seen. The few critical remarks I have offered in this section are certainly not sufficient to show that either of these two paths is unviable. My aim here was merely to draw attention to the fact that proponents of both views share a common preconception of their task, and that the problematic nature of this task derives from a number of additional premises which have largely have gone unnoticed and unquestioned so far.

Let me add to these observations thetically a number of claims that are argued for elsewhere.¹⁷ Principles (P2) and (P3) are elements of a more comprehensive network of presuppositions constituting the dominant research paradigm in ontology. At the very heart of this network of implicit assumptions or the 'substance paradigm' is the following principle:

- (P4: The primacy of particulars:)
All concrete individuals are particulars.

¹⁷ Cf. Seibt 1990, 2005, and 200+c.

A so-called 'particular' is an entity that (i) has a determinate unique space-time location and (ii) (has this location necessarily since it) is individuated in terms of its location.¹⁸ Traditionally the category of a particular has been complemented with a 'dual category,' the category of 'general' entities. General entities (*being white*, *being a cat*) do not have unique locations but may be multiply located in space-and-time. Thus they are individuated not in terms of a unique location but either by the 'distinctness simpliciter' of the 'suchnesses' that they are or in terms of functional or causal aspects associated with these suchnesses. Whether general entities are indeed needed in ontology, and how one might conceive of their presence in spacetime, notoriously has been the subject of the longstanding debate about 'universals'. In contrast, apart from Leibniz' attempt to defined concrete individuals in terms of universals, the commitment to the ontological primacy of particulars virtually has gone unchallenged. Also participants in the debate about persistence proceed without further ado from the theoretical juncture that persistence is to be accounted for in terms of the transtemporal identity of a *particular* continuant (endurance view) or else in terms of the *particular* temporal composites of a transtemporally extended *particular* (perdurant view). Even though only endurantists are still prepared to invoke explicitly the traditional label 'substances', endurantists and perdurantists alike proceed from the core assumption of the substance-ontological tradition: that discrete, bounded, concrete particulars are 'primary' in being.

In the next section I will briefly sketch an ontological scheme that operates outside of the strictures of the substance paradigm and thus, as any paradigm-transcending proposal, at first sight will appear as 'unorthodox' in the sense of 'unnatural'. But cooks and musicians, or chemists and biologists, should find the scheme quite intuitive, since it ties in closely with the stuff and function geared component of our common sense reasoning, where we individuate entities in terms of what they do, know that two portions combined are another portion and that mixing

¹⁸ 'Spacetime' is used vaguely here, without commitment to relativity theory. An entity has a determinate unique spacetime location iff it holds that for any point or moment in time at which it exists, it is located in precisely one bounded, connected spatial region. (Note that a region that is 'connected' in the topological sense might be 'multiply connected', i.e., include holes.) Furthermore, that x and y have different locations is sufficient and commonly also necessary for their being different particulars. Some trope ontologists allow for particulars ("abstract particulars") to be spatially superposed at a time. But location is always a necessary component of the identity conditions of particulars.

individuals may generate new functional properties. As I will try to show individuals that abide by the logic of activities or spatiotemporal dynamic stuffs provide us with better ontological explanations than the traditional description of our world as assembly of (three- or fourdimensional) “starren Wirklichkeitsklötzchen” (F. Paulsen).

2. *The theory of general processes*

The ‘theory of general processes’ (hereafter ‘GPT’) is a new ontology in the sense that it introduces a new ontological category and a new formal framework (a non-standard mereology) to describe the basic relationships obtaining between general processes. However, in GPT the general methodological commitments of analytical ontology are retained and thus the approach differs markedly from Whitehead’s “philosophy of organism,” where even basic methodological parameters are modified.

Let me preface the following remarks on GPT with a quick reminder of the theoretical character of ontological descriptions, which Strawson’s distinction between “descriptive” and “revisionary metaphysics” has obfuscated in most unhappy ways. With respect to descriptive theoreticity, ontology resembles science. A scientific theory furnishes theoretical descriptions of a domain using theoretical terms (e.g. “harmonic oscillator”, “spin”) that—assuming here a non-instrumentalist interpretation—denote theoretical entities and features. These theoretical entities and features are introduced together with ‘models’ (e.g., ideal springs, rotation), which help us (scientists and non-scientists alike) to understand the theory’s theoretical terms and ultimately account for the explanatory function of the theory’s domain descriptions. Analogously, ontological descriptions use *theoretical terms*, such as ‘substance,’ ‘property,’ ‘trope,’ ‘occasion,’ ‘mode,’ ‘relation,’ ‘state of affairs,’ etc. Such theoretical terms (ontological category terms) label *theoretical entities* (ontological categories), which we (ontologists and non-ontologists alike) understand in terms of a model. The model for substances are things, for example, and much of the longstanding popularity of substance ontology derives from the central function of things in practical contexts, in particular their transtemporal persistence.

The new category label ‘general process’¹⁹ thus denotes theoretical entities of a certain sort, and should in the first instance be understood in

¹⁹ Alias “dynamic masses” and “free processes” in earlier versions of the theory, cf. Seibt 1990, 1995, 1996, 1999, 2000, 2001, 2003b.

terms of (but not be confused with!) their model, namely, “subjectless” activities. A subjectless activity is an occurrence that might involve, but is not, the doing or acting of a person or thing (or of a collection of persons or things). For example, snowing, blowing, thundering, erosion, light or electromagnetic radiation are subjectless activities in this sense—they are presences of dynamic features that have no logical subject.²⁰ Subjectless activities have seven characteristic aspects (which apart from the first one also hold for activities in general).²¹ (i) Subjectless activities are occurrences in their own right rather than modifications of persons or things—like things, and unlike properties and relations, they are *independent* in the sense that their occurrence in space and time does not necessarily require the existence of a different sort of entity they occur in or qualify (they may of course be constituted or caused by other entities).²²

(ii) They are *temporally extended*—there are no instantaneous activities.²³ (iii) However, quite unlike things, and much like stuffs (water, wood, etc.) subjectless activities occur in space and time both with indeterminate and with determinate locations (cf. ‘there is lots of rain in Denmark’ vs. ‘on Oct. 12 it rained in Aarhus between 8am and 1pm). Most importantly, subjectless activities do not necessarily occur in a unique spatiotemporal location, i.e., in ontological terms, they are *not particulars*. While things are located at any time in one place only, subjectless activities are multiply locatable like properties and stuffs—they can, and mostly do, occur in many places at the same time. ‘It is snowing’ can be true of many different scattered regions at the same time. (iv) Subjectless activities also resemble stuffs in that they do not come in ‘natural units’ and are *not countable*, but

²⁰ Sellars, following C.D. Broad, takes “subjectless” or “pure” activities to be expressed by sentences with “dummy subject”, cf., ‘it is snowing,’ ‘it is lightening’ (Sellars 1981). Even though this might be helpful for illustrational purposes, it cannot serve as a criterion since many activities that cannot be understood as the ‘doings’ of a thing (or a collection of things) are expressed by nouns.

²¹ To simplify I here characterize subjectless activities directly in terms of ontological features such as being independent, concrete, non-particular etc. Note that the proper methodological procedure would be to show how the *logical* role of activity sentences dovetails with category features of the entities in terms of which statement about activities are interpreted. For a detailed discussion of activity statements cf. Seibt 2003b and 2004, ch. 2 and 3.

²² To be elaborated presently below: there are not instantaneous activities in the sense of stages constituting temporally extended activities. We do, however, assume that activities exist continuously in time, and thus are dynamic features that can be ascribed to any point in the time period during which they are going on.

only measurable in portions or amounts (e.g., an hour of snowing, 1000 lumens of light), which then may be counted. (v) Like stuffs and properties, subjectless activities are not necessarily determinate in all of their qualitative or functional aspects—ontologically speaking, they are *determinables*. (vi) Subjectless activities are *individuated in terms of their functional features*, rather than by their location in space and time, just like stuffs are. (vii) Subjectless activities are dynamic but they are not changes—constitutive ‘phases’ of their dynamism (for example: the change of place of every single flake constituting the dynamism of the snowing) enter the functionality of the activity not as temporal stages or phases. In contrast to developments, activities do not involve internal temporal difference.

These seven aspects of subjectless activities illustrate the main features of the new category or entity type called ‘general process’. General processes are *independent, individual, concrete, spatiotemporally extended, non-particular, non-countable, determinable, and dynamic* entities, in the sense of these terms just sketched. These category features are well-known from the ontological debate, but their combination is new and, in fact, inconceivable as long as one chooses to remain spellbound by the presuppositions of the substance paradigm. There is one additional, novel category feature of general processes, however, which I call selfpartedness or ‘automerity’ and will introduce separately in the following section. The category features of general processes receive a more precisely formulation, explicitly or implicitly, from within the context of a formal framework, a mereology on general processes (GPM). Thus GPT is the theory of general processes as axiomatically defined within the mereology GPM.

For present purposes a quick look at the main observation underlying the construction of GPM will suffice. Ontologists commonly assume that the meaning of the part-whole relation is formally articulated by the axioms of “classical mereology” (however variously implemented). Upon a closer look, however, the relation modeled by systems of classical mereology is the relation ‘is a part of’ which holds for particular (location-individuated) and countable entities only. (That this clandestine restriction to countable particulars has gone virtually unobserved is yet a powerful documentation of the theoretical bias effected by the substance paradigm.) In contrast, the relation ‘is part of’ can be used with all sorts of arguments, both location-individuated (particular) individuals and functionally individuated (non-particular) individuals. Here are some real life examples

taken from the web²³: “blogging is part of life,” “Russia is part of the West”, “Music is part of God’s universe,” “All I See Is Part Of Me” (book title), “Learning to negotiate is part of the advocacy process,” “my heritage is part of who I am,” “Is part of your college education missing?”, “Boston is part of the Islam,” “Loss is part of living,” “Syria is part of the solution,” “looking immaculate is part of what I do,” “having a good signed contract is part of running a professional business”, “Pain is part of running marathon,” “Hopping too is part of running.” As usages like these convey, the expression ‘is part of’ states a highly general relation of functional ‘belonging with’ (both as contributory or consequent), without implications concerning spatial or temporal containment. Most importantly, in many cases this relation of functional belonging with is not transitive. For example, (i) through (iii) in the following do not entail (iv):

- (i) Changing diapers is part of caring for your baby.— (ii) Opening the box with wipes is part of changing diapers.— (iii) Pressing your thumb upwards is part of opening the box with wipes. — *(iv) Pressing your thumb upwards is part of preserving the baby’s health.

Thus this highly general sense of ‘is part of’ is not adequately captured by the transitive relation ‘<’ as axiomatized within classical mereology. Instead in GPM an alternative axiomatization of our common sense mereological reasoning is introduced, based on a non-transitive relation (read: ‘is part of’, ‘belongs with’; abbreviated ‘G’).

Since ‘G’ is non-transitive, GPM-parthood reaches only into the immediate or ‘first-level’ parts of an entity. This makes it possible to express mereological relationships in a much more differentiated fashion, namely, relative to partition levels.

²³ Note that ‘is part of’ gets 204 million hits on google, while ‘is a part of’ yields a meager 11,8 million. For details on GPM compare Seibt 2004, ch. 5; ‘is part of’ is the generic relation that subsequently can be further specified into spatiotemporal part, material part, functional presupposition etc.

To introduce the notion of a partition and a partition level, we first define parthood resulting from the n th iteration of ' ζ ':

(D1a) $x \zeta_n y \leftrightarrow$ for all n in an ordered sequence of natural numbers N :

if $n = 1$ then $x \zeta_1 y \leftrightarrow x \zeta_1 y$;

if $n > 1$ then $x \zeta_n y \leftrightarrow \exists z (x \zeta_{n-1} z \ \& \ z \zeta_{n-1} y)$

We can then take the transitive closure over a sequence of length N of iterated applications of ' ζ ', to define a part-relation across partition levels with transitivity restricted to level N :

(D1b) $x \zeta_N y \leftrightarrow x \zeta_n y \text{ or } \forall n > 1 \text{ in } N, \exists z (x \zeta_{n-1} z \ \& \ z \zeta_n y)$

For a given entity α , any entity y in the field of the relation ' $\alpha \zeta_N y$ ' belongs to the so-called *N-partition* of α . In contrast, any entity y in the field of ' $\alpha \zeta_n y$ ' (the n -th iteration of ' ζ ') belongs to the so-called the *partition-at-level- n* of α . That is, the *N-partition* of α comprises entities at all partition levels up to and including level m , where m is the last member of N , while the *partition-at-level- n* of α denotes entities at *one* level only.

The *n-parts* of an entity α are those entities y for which ' $y \zeta_n \alpha$ ' holds:

(D2a) x is *n-part* of $y \equiv_{df} x \zeta_n y$

In order to refer to processes at *any* or *all* partition levels of a process α below or above a certain 'threshold' we can either use existential or universal quantification on the i -parts of α , with $i \leq n$, or $i \geq n$. On the basis of (D2a) we can now state that ' ζ ' is irrelative and antisymmetric relative to a partition level:

(Ax1) $\neg x \zeta_n x$

(Ax2) $x \zeta_n y \rightarrow \neg y \zeta_n x$

This makes room for the possibility that a *whole* α can make a *functional contribution* to *one* of its *own n-parts*. Similarly, identity in GPM is defined relative to a partition level with the following two axiom schemas, as identity at a level n (Ax3a) and identity across partition level up to depth n (Ax3b):

(Ax3a) $\forall z (z \zeta_n x \leftrightarrow z \zeta_n y) \leftrightarrow x =_n y$.

(Ax3b) $\forall z (z \zeta_{\leq n} x \leftrightarrow z \zeta_{\leq n} y) \leftrightarrow x =_{\leq n} y$.

Two terms are coreferential (in common ontological parlance: 'two entities are identical') if they have the same n -parts or $\leq n$ -parts. These two identity principles account for the context-relativity of our judgements of sameness; in some contexts coarse-grained comparisons suffice, while others require an in-depth investigation. In this way GPM can be used to

reconstruct the insights on either side of the various debates about, e.g., the 'extensional' vs. 'intensional' identity conditions of events.²⁴

The new technical devices of *parthood* at level n and *parthood up to level n* have many fruitful applications in ontology, both with respect to traditional tasks such as the analysis of persistence and change, as we shall see presently, as well as with respect to new tasks in the ontological interpretation of scientific core concepts. For example, in GPM we can define various types of process interaction (complex processes with more parts or less parts than their parts) and in terms of these many different types of interactive process organizations, such as linear mechanisms, autocatalysis, and self-maintenance.²⁵

GPT, the theory of general processes, uses the formal framework of GPM to explicate the core thesis of GPT that, in Wilfrid Sellars' happy phrase, the world is "the ongoing tissue of goings-on"²⁶—all there is, is a general process. In line with Aristotle's intuition that being is linked to individuality, GPT is to show that this intuition can be coherently developed if we—pace Aristotle—separate individuality from particularity. Whatever we talk about in common sense and science is a functionally individuated individual, a dynamics, a "tode ti on the go", which may be, but does not need to be, uniquely located. An amusing illustration of the 'general spirit' of GPT-interpretations can be found in Quine's playful remark that process ontologists read the sentence "a white cat faces a dog and bristles" as "it's catting whitely, bristlingly, and dogwardly."²⁷ The main task in GPT is to devise a comprehensive typology of general processes or, less technically speaking, 'dynamics.' To this effect the dynamic individuals are classified in terms of parameters of five basic

²⁴ Since (Ax3a, b) are versions of the classical Proper Part Principle, GPM is a so-called 'extensional mereology', even though the notion of parthood is 'intensional' (i.e., not the classical notion of an extent-part drawn from geometric intuitions).

²⁵ Cf. Seibt 2004b.

²⁶ Sellars 1981, 57.

²⁷ Cf. Quine 1985, 169. I owe this illustration to L.B. Puntel, who occasionally uses it in similar fashion to indicate the flavour of his ontology of primary states of affairs (Verhalte), cf. e.g. 1993. Many years ago, in the early 1980s, Puntel identified an "object-ontological dogma" in contemporary ontology and shared these research explorations with his students in lectures and seminars. I am deeply indebted to him for these early pointers, providing the core inspiration for a common search of 'ontology beyond the myth of substance', even though along different paths of implementation. For the currently most sophisticated and advanced philosophical system in this vein see his 2006.

evaluative dimensions, namely, participant structure, dynamic composition, dynamic shape, dynamic context, and their "mereological signature" or automerity pattern, which the following section shall explain.²⁸

3. *Selfpartedness and selfcontainment*

One of the category features of general processes is novel and requires special elucidation. Let us look thus again at (subjectless) activities, the model of general processes. Aristotle refers to common stuffs such as water and flesh frequently as "like-parted (homoeomerous) bodies": they are "substances that are composed of parts uniform with themselves."²⁹ As various contemporary authors observed, there is an analogous mereological condition for activities, holding with respect to time—they are 'monotonous' or 'homogenous' occurrences where beginning, middle, and end of the interval of their duration are 'of the same nature as the whole'.³⁰ Just as any spoon of a puddle of water is like the whole, namely, an expanse of water, so any minute of an hour of snowing is like the whole, namely, a period of snowing. Thus we can formulate the following general mereological condition:

Likepartedness or homoeomerity: An entity of kind K is homoeomerous iff all of its spatial or temporal parts are of kind K.

That activities are homoeomerous in time is a claim that contemporary authors frequently connect with Aristotle's observation that activities such as seeing and knowing are "complete" at any time at which they occur, in contrast to directed developments such as walking-to and build-a-house:

²⁸To give some hints at least: *Participant structure*: number and type of causal agents and patients. *Dynamic constitution*: linear vs. nonlinear additivity of n-parts of dynamics ('emergence'). *Dynamic shape*: basic types of (parts of) trajectories in phase space, some of which correspond with distinctions familiar from linguistic theories of "Aktionsarten" and verbal aspects. (telic/atelic, ingressive, egressive, repetitive, conative etc.). *Dynamic context*: linear vs. non-linear causal consequences, such as the air flow around a kite, vs. non-linear consequences in the generative environment of the process, such as changes in ecosystems that alter selection pressures (cf. Bickhard/Campbell 2000, 343).

²⁹ Cf. *History of Animals*, 487a2.

³⁰ Cf. Vendler 1957; Gill 1993, 369, 370; Dowty 1977; Verkuy 1978, 224; Mourelatos 1978, 431.

"For one cannot in the same moment both be taking a walk and have taken it, nor be house-building and have house-built...But at the same moment the same thing has seen and is seeing and is thinking, and has thought" (*Metaphysics* 1048b30-33)

Upon a closer look, however, Aristotle's observation on what I call the 'temporal distributivity' of activities expresses an even more remarkable mereological condition than *likepartedness*.³¹ Since activities are purely functionally individuated, it does not make sense to distinguish between an activity and its nature. Of course we may say that every minute of an hour of snowing is of the same nature as the whole, but then we are talking not about the activity of snowing but about a (or any) particular spatiotemporal amount of snowing. For the activity itself, the following holds:

Selfpartedness or automerity: An entity E is automerous iff for any spatiotemporal region R in which all of E occurs it holds that any smallest region r of R is also a region in which all of E occurs.

This condition states in effect that activities are temporally extended yet do not have temporal parts in the sense in which developments have temporal parts, namely, as stages or phases that differ in their nature from the whole or, equivalently, that *are* different types of occurrences, differing from each other and the whole. Rather, activities (subjectless and subjectbound) occur in all of the temporal parts of the region in which they occur.

Of course, on the reading of 'part' as defined in classical mereology the very idea of selfpartedness or automerity is incoherent.³² No entity can have itself as a part, since this would be in conflict with the idea that parts are always supplemented by another part to form a whole ("supplementation principle"). On the basis of GPM, however, selfpartedness can be coherently articulated, since in GPM the part-relation (a) has the broad sense of 'belongs with' rather than extensional containment, and (b) is not transitive.

³¹ In my view this passage should *not* be taken to suggest, though, that Aristotle's notion of *energeia* refers to our common sense notion of an activity; for a detailed discussion cf. Seibt 2004, ch. 3.

³² Of course, in mereology 'x is a part of y' is sometimes defined as 'x is a proper part of y or x = y'. But this is not at issue here.

For example, the dynamics *snowing*, call it α , is located in *some* spatiotemporal region(s), since it is a concrete entity. Thus it is part of what α is that it is located in some region R .³³ Any such amount of α in R is a dynamics in its own right, however—it is a specification of α for that particular region (snowing on Mount Everest in region R' differs from snowing at the Danish coast in region R'' etc.). Let β be the name for some amount of α in R . Part of what it is to be β is to be α (compare: part of what it is to be my cat Ally is to be a cat). Another part of what it is to be β is to be the sum of regions $R_1, \dots, R_n$ (which are the temporal parts of R). As before, due to automerity of α it holds that being an amount of α is part of being any of the regions $R_1, \dots, R_n$. Call these amounts $\gamma_1, \dots, \gamma_n$. As before for β , for any γ_i it holds, that being α is part of what they are. Graphically the feature of selfpartedness has the following representation:

³³ Vice versa, for any such region R locating α it holds that R 's being an amount of α is part of what R is in interaction with α . (This claim can be connected with both absolutist and relational conceptions of spacetime). Note that an amount of α is, more precisely, a 3-part of α (roughly: part of α 's being located in a certain region, which is an interaction product between α and spacetime), but the contracted claim holds as well.

Thus, without getting into conflict with the Supplementation Principle in GPM an entity (*snowing*, *water*, *light*) can contain itself as part of a part, as something that belongs with something that belongs with it. Very roughly, the many determinately located snowings are part of what snowing is, and it is part of what the many determinately located snowings are that snowing is part of what their parts are.

Selfcontainment in this sense is, I submit, the sense of temporal continuity at issue in our common sense claims about activities existing continuously throughout the period at which they exist. Temporal continuity is the literal ubiquitous recurrence of one and the same feature, down to the smallest conceivable regions or 'points in time'.³⁴

Let us return then to the features of likepartedness and selfpartedness as stated above. Even assuming that both can coherently be formulated (the latter for functionally individuated entities), one might argue that claims about the likepartedness or selfpartedness of stuffs and activities are empirically false. Surely not *every* spatial part of a (spatiotemporal) region of water is again a region of water—regions smaller than size a water molecule would not do—and not *every* temporal part of a (spatiotemporal) region of running is again a region of running—periods shorter than the lifting of a foot will not qualify.³⁵ In other words, while the features of likepartedness and selfpartedness as formulated above stipulate complete 'homogeneity', homogeneity only exists down to a certain 'grain-size.' This objection is a fallacy, equivocating on the terms 'water' and 'running.' It involves a clandestine switch in perspective: the stuff *water* is here conceptualized in analogy to fruit salad, as a mixture of things (molecules), and the activity *running* is considered here as an iterative sequence of developments (lifting the right foot, shifting weight, lifting the left foot etc.).³⁶

But the fact that such equivocations on common nouns and verbs are possible is very significant in its own right, in two respects. First, the objection demonstrates that we switch with facility from a function-geared to an extent-geared perspective, and suggests that we abandon the

³⁴ This notion of 'concrete continuity' differs from, yet can be connected to, the notion of mathematical continuity as represented by the real numbers'.

³⁵ Cf. for example Gill 1993.

³⁶ Such reconceptualizations are almost forced upon us once we focus on the identity (within some coordinate system) of the spatiotemporal region occupied by a certain amount of water or running; since the parts of spatiotemporal regions are different, we search for differences in their fillings.

traditional strategy of associating ontological interpretations with single linguistic expressions; rather, the ontological interpretation of a noun or verb very much depends on the sentential context, even on the discourse context (compare: 'Kim ate oats' (activity) vs. 'Kim ate an apple' (development)). Second, the objection points us to a possible way to turn a dichotomy into a distinction within a unified classification system. The conceptual shift from stuffs to mixtures and from activities to sequences of developments is to show that only *some*, not *all* parts of the entity are like the entity or contain the entity itself. Interestingly, there are also entities for which it holds that there are *no* parts like them or containing them, namely, things and events (developments). For example, no spatial part of my computer is a computer, and no temporal part of a baptism or an explosion of a bomb is again a baptism or an explosion of a bomb (and similarly for selfpartedness).

Thus in GPT general processes can be sorted into different types according to their 'mereological signature', i. e., in terms of their likepartedness (homeomerity) and selfpartedness (automerity) in various dimensions:

Maximal, normal, minimal homomerity: An entity α of kind K is maximally / normally / minimally likeparted iff *all* / *some* / *none* of the parts of the spatiotemporal extent of α are of kind K .

Maximal, normal, minimal automerity: An entity α is maximally / normally / minimally self-contained iff a spatiotemporal region in which α exists has *only* / *some* / *no* spatial or temporal parts in which α exists.

To illustrate, consider the following graphics of normal, maximal, and minimal automerity in space, with '(MA)' denoting the minimal amount of 'a':

For example, the ontological correlates of our talk about activities ('activity-processes') are temporally maximally automerous, the ontological correlates of our talk about stuffs ('stuff processes') are spatially normally automerous, general processes denoted by talk about amounts of stuffs are spatially normally homomerous but minimally automerous, and temporally maximally automerous, general processes denoted by talk about developments are temporally minimally homomerous and automerous, and so forth.

All general processes are thus selfparted (and by implication: likeparted), but to different degrees in different dimensions. What matters for our purposes here, however, is the fact that maximal temporal automerity, i.e., selfcontainment in time, provides a new way of making ontological sense of our common sense talk about persistence as temporally continuous existence of the same individual.

4. Persistence as recurrence

On the basis of the foregoing definitions and considerations the new account of persistence is already in sight. Briefly put, while the occurrence of a development is a sequence of different dynamic features, the occurrence of an activity is the continuous recurrence of one and the same dynamic feature, namely the activity itself. Activities are maximally selfparted in the temporal dimension. Maximal selfpartedness, however, implies sameness in time in the sense of endurance as commonly defined ('at any time at which an entity exists, all of it exists'). Precisely this sense

of sameness in time is also at issue when we talk about the persistence of things and stuffs. When we speak about stuffs and things persisting we can take ourselves to denote dynamics that are temporally maximally selfparted. In a nutshell, then, the persistence of things and stuffs is indeed transtemporal identity, and the best sense we can make of transtemporal identity is in terms of the recurrence of the same dynamic individual.

This is the core idea of the so-called *recurrence account* of persistence. Let me add now some of the details working along the desiderata for an account of persistence as we encountered them in our discussion of endurance and perdurance accounts in section 2. A successful account of persistence should:

- (D1) cover the data for a theory of persistence, i.e., explain the inferential role of statements about persistence and chance;
- (D2) avoid a commitment to individual essences;
- (D3) avoid postulating that temporally extended entities of kind K are ontologically constituted by instantaneous entities of kind K;
- (D4) avoid a commitment to a specific theory of time, i.e., either 'presentism' or 'eternalism'.

As I will argue now, the recurrence account of persistence holds out the prospect of combining the virtues of endurance and perdurance approaches, while avoiding their vices. Let us begin with a closer look at (D1), the coverage of inferential data. As pointed out above, there are two main inferential data to observe. First, a statement about the alteration of a thing such as [3] implies a statement about transtemporal sameness such as [4]:

[3.] The Statue of Liberty was first copper-colored, but turned green over the course of the years.

[4.] The green statue you are seeing now is the same as the copper-colored statue dedicated in 1886.

Second, a statement which assigns mutually exclusive features to a thing such as [5]:

[5.] In 1886 it was true to say: 'The Statue of Liberty is copper-colored', now it is true to say: 'The Statue of Liberty is green.'

entails a statement about an alteration, such as [3], but also a statement about difference, such as [6]:

[6.] The Statue of Liberty as it was then (as it exists in 1886) is not the same statue as the Statue of Liberty as it is now (as it exists in 2006).

Focusing first on the first inferential datum, [3] and [4], we can endorse the basic motivation that drives the endurance approach and confirm that statements of transtemporal sameness such as [4] have the inferential import of identity statements:

(D1-a) Statements about transtemporal sameness are to be interpreted in terms of identity, not unity.

On the other hand, in view of the second inference from [5] to [6], we must *not* follow endurantists in the assumption that statements of transtemporal sameness and statements about alterations have the same logical subject. One of the profound insights of perdurantism—even though proponents of perdurantism do not make anything of it—is that perdurantism takes a statement about a change such as [3] to be about one *temporal part* in comparison to another, while a statement about transtemporal sameness, such as [4], is about a *temporal whole*, i.e., about another entity. Perdurantists *de facto* reject the substance-ontological presupposition (P2) that what persists in an alteration *is* the very same entity which is said to have changed. This enables perdurantists to take statements about transtemporal difference like [6] at face value, as statements about numerical difference, while endurantists are forced to read [6] as stating a qualitative difference only. Here we need to side with the perdurantists' interpretation of the data, i.e., we need to hold:

(D1-b) Statements about change entail statements of numerical difference (and statement of qualitative difference).

In short, while endurantism does not acknowledge that [6] expresses numerical difference, it fails with respect to (D1-b); perdurantism does not acknowledge that [4] expresses identity and thus falls short with respect to (D1-a).

Consider now the GPT- interpretations of [3] through [6], stated here in an 'intuitive' version where definitions are replaced by informal explanations.

[3-GPT]: Sentence [3] above states that a complex dynamics α denoted by 'the Statue of Liberty' is part of an interaction dynamics δ_1 (involving other dynamics such as light, air, sensory processes) which occurs in time period t_1 and yields (among others) as interaction product the dynamics β denoted by 'x is copper-colored', and is part of interaction dynamics δ_2

(involving other dynamics such as light, air, sensory processes) which occurs at time period t_2 and yields (among others) as interaction product the dynamics γ denoted by 'x is green'.³⁷ Essentially, the sentence says of that which is going on in a certain region that it is involved in two different interactions at two different times. From this we may conclude that the way it was/is going on in these two interactions still count as amounts of it, as in [4]:

[4-GPT]: Sentence [4] above states that there are two dynamics x_1 and x_2 , and x_1 is part of the interaction dynamics δ_1 and x_2 is part of the interaction dynamics δ_2 , and the dynamics that x_1 is an amount of is identical to the dynamics that x_2 is an amount of, namely, α .

[5-GPT]: Sentence [5] above highlights that δ_1 and δ_2 have different parts (β and γ , respectively) and thus are different dynamic individuals.

[6-GPT]: Sentence [6] says that there are two dynamics x_1 and x_2 that are part of the interaction dynamics δ_1 and δ_2 , respectively, and x_1 is an amount of α_1 and x_2 is an amount of α_2 , and α_1 and α_2 are different specifications of α .

Without the formal details of the predicates 'is an amount of' and 'is a specification of' some aspects of these process-ontological interpretations of our common sense discourse are bound to remain vague, but the main ideas, I hope, will stand out nevertheless:

- (i) Statements like [4] and [5] are comparisons of 'what is going on' in two different spatiotemporal regions.
- (ii) A 'coarse-grained' or 'functionally abstractive' comparison results in the affirmation of sameness or numerical identity of that which is going on in each case, as in [4]. Such a comparison is 'mereologically shallow', taking into account only a few levels in the functional partition of the dynamics involved.
- (iii) A more 'fine-grained' comparison will reach into 'deeper' partition levels and reveal difference, as stated in [5]—what is going on in one region functionally resembles what is going on in the other region in that the parts are the same, yet the specifics (what is part of being such a part of what is going on) are different.

In short, statements about persistence and change involve different calibrations of the 'lens of specificity' that guides our comparisons of functionally individuated individuals: persistence statements express the

³⁷ A dynamics is always located in an extended spatiotemporal region; the expression 'x occurs at t' is derived.

transtemporal identity of *more generic* individuals (dynamics), statements about change express the difference between *more specific* individuals (dynamics).

Turning to (D2), then: does the recurrence theory of persistence avoid a commitment to individual essences? The account is committed to partitions of dynamics and thus in a sense to 'functional' essences of more or less generic individuals, but not to essences of *particular* individuals, i.e., entities which are *necessarily* unique, and only the latter ones are problematic. Moreover, in GPT generic or determinable individuals are concrete. The idea of explaining persistence via the transtemporal identity of a generic entity has been considered occasionally, following an idea of Whitehead's.³⁸ But retaining traditional substance-ontological presuppositions—and in this one respect we need to reckon even Whitehead among the 'substance ontologists'—these authors immediately linked genericity to abstractness and were thus forced to explain the persistence of concrete individuals indirectly, in terms of their 'instantiating' the same abstract patterns or universal, rather than in terms of transtemporal identity. In contrast, the recurrence account of persistence can take our claims about the persistence of concrete entities at face value as claims about the transtemporal identity of concrete generic individuals. This special conceptual feat, I submit, can only be pulled off if we switch to activities as our models for individuals. Universals are 'repeatables' at best in the sense of being repeated by being instantiated—the idea of anything *repeating in time* or *recurring* can only be spelled out in terms of the multiple occurrence of a dynamics, i.e., only in sense of a dynamic's selfpartedness of selfcontainment.

Consider (D3): while on the stage view the horses and tornados we claim to persist are constituted by instantaneous entities, on the recurrence view of persistence common sense predications 'horse' or 'tornado' apply to temporally extended regions and only derivatively, in consequence to the selfpartedness of these dynamics, to any temporal part of these.

Finally, as to (D4), all GPT-definitions are neutral with respect to the interpretation of time—to speak of temporally extended entities does not entail a commitment to eternalism, i.e., the claim that future and past exist just like the present. Since the data of a theory of persistence, the inferential roles of statements of persistence and chance, do not imply any specific position as to the ontology of time, (D4) is a significant desideratum—theories of persistence that can cover the data only at the

³⁸ Cf. Carter/Hestevold 1994, Simons 2000.

expense of introducing presentist or eternalist postulates are profoundly weaker than a scheme that is compatible with both.³⁹

In conclusion, the recurrence view of persistence can prove Heraclitus both wrong and right, quite in line with Heraclitean metaphilosophy. "You cannot step into the same river twice, since ever and ever new waters are flowing in upon you." But the many new waters are amounts of the same stuff *water*, a non-particular individual—the sentence thus is false. Such individuals come best in sight, however, if we dare to think that activities, such as the river's flowing, is all we are left with.

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³⁹ Note that in GPT even dynamicity is defined in such a way that it does not carry any commitments to the A-series.

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The Thread of Persistence

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Argo, their thread of life is spun.
Shakespeare, 2 Henry VI

1. Introduction

According to the folk conceptions endemic in human language and thought, physical things such as stones and stars, boats and goats all belong to the vast metaphysical phylum called *continuants*: things which persist through time by enduring, being present as a whole at any time at which they exist, and lacking in phases or temporal parts. In this they contrast with the other great phylum of *occurents*, such as eruptions, births and weddings, flowings and growings which persist through time with different temporal parts or phases at different times. As we standardly conceptualize continuants and occurents, they persist in different ways: continuants by enduring, occurents by perduring.

Modern scientific metaphysics offers two major general accounts of how continuants persist. One is the *endurance* theory, according to which the folk conception of continuants as endurants is literally correct, to be taken at face value, and enduring is a primitive, *sui generis* metaphysical concept. The other is the *perdurant* theory, according to which continuants are in fact occurents, and have temporal parts, folk conceptions notwithstanding. Perdurant theories come in several different flavours, but they all basically deny conceptual appearances and insist that a proper metaphysical account of continuants requires a conceptual revision to accord stones and other physical things temporal parts.

I think that both the endurance theory and the perdurance theory are wrong, and that the metaphysical truth is to be found in a third theory which I call the *invariance* theory, which is distinct from either of the others while preserving the attractive features of each.¹

¹ For previous attempts to enunciate this theory see my three papers of 2000 listed among the references.