

J. SEIBT

PROCESS THEORIES CROSSDISCIPLINARY STUDIES ON
DYNAMIC CATEGORIES

1. INTRODUCTION

Processes constitute the world of human experience – from nature to social reality to cognition itself. However, by and large, the centrality of processes does not appear to be reflected in theoretical descriptions of nature and the human domain. Frequently processes are represented in a reductive fashion – in terms of their results, input-output pairs, or sets of state sequences summarized by linear functions. Disciplines without quantitative, algebraic-geometrical tools make do with metaphorical, haphazard, and highly domain-specific classifications of occurrences. Perhaps most remarkable is the general neglect of dynamic entities among ontologists, with a few exceptions, notably Whitehead: dynamic entities are neither properly investigated nor employed as descriptive primitives. Throughout the history of ontological research, the world of human experience has been presented as an assembly of ‘static’ entities: substances, attributes, relations, facts, ideas – and more recently, tropes, temporally relativized property exemplifications, or four-dimensional expanses.

But the traditional fixation on the permanent is not a requirement of theory construction *per se*. This book contains a collection of thirteen articles showing the fertility of a process-gearred perspective. Ten of these articles are based on talks presented at an interdisciplinary research meeting (*Processes: Analysis and Applications of Dynamic Categories*, Sandbjerg Gods, Denmark, June 5–8, 2002) which brought together researchers from widely different fields (formal ontology, cognitive science, linguistics, semiotics, ancient philosophy, ethics, philosophy of music, music theory, theoretical psychology, theoretical biology, philosophy of chemistry, and philosophy of physics). The Sandbjerg 2002 meeting was internationally the first interdisciplinary conference on processes without exclusive commitment to American process metaphysics (Whitehead, Dewey, James). Three further articles were included since they are apt further to contri-



bute to the overall theoretical purpose of the collection, namely, to present extant non-reductive theories of processes, and to identify theoretical motivations for the development of process-based or process-gearred theories in different areas of application. In contemporary ontology, A.N. Whitehead's 'philosophy of organism' certainly stands out as an example of a non-reductive theory of processes with impressive explanatory scope, and two of the following contributions demonstrate the fertility of Whiteheadian approach. But the collection is primarily aimed to draw attention to non-Whiteheadian research on process within and outside of philosophy.

Like research on 'complexity' and 'emergence', research on 'process' is a topic which calls for a cross-fertilizing interdisciplinary approach. It is certainly an overstatement to say, adapting the Kantian *dictum*, that process ontology must be 'empty' without process-gearred theories from other disciplines, or that the latter remain 'blind' without the former. But the most productive strategy for the development of a process-based category theory in ontology is to tailor such a scheme not only to the familiar problems in ontology but also to *descriptive tasks* in the natural and human sciences. And conversely, in order to revise basic assumptions in their field, researches in the natural and human sciences can benefit from new *descriptive tools* furnished by ontologists and philosophers of science. One of the focal points of such cross-fertilizing research is the development of (regional or general) *typologies of processes*, and several of the articles in this volume address this issue explicitly.

Following the two main objectives of the workshop, the contributions to these proceedings have been grouped under two headings: *analysis and application*. Of course, since in most of the following contributions dynamic categories are both analyzed and applied, the division is somewhat arbitrary and reflects merely a topical emphasis. Authors of Part I are mainly concerned with the semantic analysis of our ways of talking about dynamic entities (processes, events, changes, developments, actions, motions etc.); or with the ontological analysis of these entities. Authors of Part II constructively apply extant process-ontological frameworks to specific explanatory tasks (Parkan, Fortescue, Christiaens, Emmeche), or develop process-ontological tools for a specific domain of application (Needham, Manzotti), or show how certain research domains could gain from a process-gearred perspective and what kind of descriptive tools are needed for this purpose (Bickhard, W. Christensen). For production-technical purposes the contributions by Manzotti and Emmeche had to be put last, but otherwise the papers in each part are arranged in what appeared the most natural systematic order, and, in particular, with a view to the chronology of research programs reported. The reader should keep

in mind that many of the contributions to this volume of *Axiomathes* are primarily designed to serve as research reports; the full picture behind the sketch is to be found in the references.

Part I begins with an exposition of Aristotle's analysis of dynamic categories. This is, in fact, less for historical than for systematic reasons since Aristotle's analysis is not only the first in Western ontology but it is also by no means superseded (Aristotelian criteria for the difference between change and activity can be traced in almost any current formulation of this distinction in philosophy and linguistics). Mary-Louise Gill, one of the leading scholars in her field, presents a reading of the core of Aristotle's metaphysics that centers on Aristotle's analysis of *energeia* (activity). As one might rephrase Gill's main thesis, the primary task of metaphysics in Aristotle's view is to give an account of substance, and precisely this is possible only if the unity of a substance is understood as an activity of sorts. Gill sets out by sketching the problem that Aristotle's analysis of *energeia* is supposed to address. In order to accommodate dynamic phenomena, Aristotle suggests that both the alteration and generation (destruction) of substances can be modelled as the attainment of a form by an underlying subject (matter). As Gill highlights, this simple 'replacement model' of change cannot be combined with Aristotle's main criteria for 'substancehood', in particular the requirements that any substance should be (a) a 'separate this' and (b) unified. Particular objects and living organisms qualify with respect to (a) but as composites of matter and form they fail to be genuine unities. To regain the unity of substance, Gill argues, Aristotle refines his model of dynamic phenomena by introducing the technical terms of potentiality and actuality and distinguishing two senses of each. When someone learns Danish she undergoes a *change*: she actualizes a 'first-level potentiality' of becoming a speaker of Danish and *acquires* a second-level potentiality or capacity to speak Danish; when she *exercises* this capacity, i.e. when she actualizes the second-order potentiality to speak Danish, she engages in an *activity*. The presence of a form in a substance, Gill argues, is to be understood on the model of an activity, as the expression of a capacity. But this is not all. The capacities expressed in the being of Socrates, this plant, or this table, are highly specific capacities involving both 'formal' and 'material' aspects. The wooden sphere exercises the capacity of being a *wooden* sphere: not just the capacity of being spherical, but also a complex capacity that includes the functional aspects of woodenness which only a certain type of matter can afford. The forms or functional roles a substance can express depends on its matter, and this in turn stands in an "essential relation" to the entire functional role of the substance, as that which affords a certain functional role. On

Gill's reading, then, the concept of an activity (*energeia*), or a capacity's being exercised, allows us to conceive of an essential mutual correlativity of form and matter. The being of substances is the *interaction* between the performance of a certain functional role and that which affords that functional role – an interaction that results in the required type of unity.

The ontological tradition has read Aristotle's investigations into substance in different, simpler ways, largely disconnecting the thesis of the primacy of countable enduring particulars from his analysis of dynamic phenomena. (Mis)guided by the category dualism of predicate logic, early analytic ontologists implemented the most simplistic version of the substance-ontological tradition – an illusory snapshot view of the world sporting particulars connected to universals by mysterious 'ties of exemplification' – which continues to influence theory construction in analytical ontology to the present day. While Whitehead opted for an (almost) wholesale replacement of traditional presuppositions, proponents of so-called 'revisionary' analytical ontologies by and large still pursue the snapshot view, even if this time based on tropes or states of affairs. But recently at least two formal frameworks have been advanced which treat processes as a fundamental category or even as the fundamental category in terms of which other categories are defined. The second and third contribution introduce these two new ontological frameworks.

Seibt's contribution presents a sketch of Free Process Theory (FPT) which she has been promoting since 1990. She begins by briefly setting out the methodological and heuristic background of FPT. First, she suggests that the tasks of ontology are best described if we conceive of ontologies as model theories of certain material inferences ('categorical inferences'). When ontologists offer an 'account' of persons (or relations, properties, states of affairs etc.) they axiomatically define certain entities whose inferential space matches with the inferential space of our commonsense reasoning about persons (or relations, properties, states of affairs etc.). Throughout its history the ontological tradition has preferred construction principles and entities geared to model the inferential space of our concept of things. In order to model the inferential space of our concepts of dynamic entities, she claims, the construction principles of the 'myth of substance' must be dispensed with. To support this claim she presents the inferential space of our talk about activities. Reviewing extant proposals in philosophy and linguistics for a classification of occurrence types denoted by verb phrases or sentences, she suggests that activities (along with the familiar 'Vendler-categories' of accomplishments, achievements, and states) are best conceived of as complex verbal aspects, defined by networks of aspectual implications. Our concept of an activity (accomplishment etc.)

is a way of ‘packaging’ a predicative content according to its *mode* of occurrence. The inferences that characterize the ‘activity mode’ imply that our talk about activities should be modeled by ontological entities which are concrete, dynamic, *non-particular* individuals, which Seibt calls ‘free processes.’ She then sketches the monocategoreal framework called FPT, a mereology with non-transitive part-relation, and outlines a typology of processes. Simple and complex free processes are classified according to (a) their pattern of spatio-temporal automerity (recurrence within a spatial or temporal region); these patterns play a prominent role in the definition of process-ontological correlates for basic common sense categories (activities, things, events, stuffs, heaps). Other classificatory parameters relate to (b) the components of complex free processes (‘participant structure’), (c) the type of dynamic composition (including weak and strong emergence), (d) the type of dynamic flow (‘dynamic shape’), and (e) the dynamic context of a process.

Heller and Herre outline the relevant part of a comprehensive ontological framework (formulated in the general language GOL) that supports data base maintenance and knowledge representation in a large variety of domains of application, and, in particular those of medical science, where short-term changes and long-term developments are traced over time in variable dynamic contexts. One of the distinctive features of this multicategoreal framework consists in the assumption of ‘chronoids’ and ‘topoids,’ i.e., portions of time and space, respectively, which are here treated as entities *sui generis*. Processes are *projected* onto disconnected or connected portions of time and space (rather than *identified* with filled spatio-temporal regions in the style of recent, four-dimensionalisms). Processes are the basic sort of ‘occurrents’; other sorts of occurrents such as histories, states, changes, and locomotions are defined in terms of certain conditions on the temporal and spatial projections of processes. Even though the framework countenances ‘substances’ and ‘moments’, these notions designate dependent and derived entities: both substances and moments (called ‘endurants’) are momentary entities, namely, the ‘time boundaries’ (three-dimensional cuts of four-dimensional projections) of processes. There is nothing in this framework that is identical through time. Persistence is a matter of momentary entities instantiating a certain universal. Nevertheless, the categorial distinction between enduring entities (endurants) and processes is specified in familiar terms as a difference in the way in which these entities relate to time. Endurants are ‘wholly present at a time-boundary’, they are ‘in time’, while processes are ‘extended in time’ and ‘have temporal parts’. Of particular philosophical interest might be the analysis of locomotion where the authors undercut

MARY LOUISE GILL

ARISTOTLE'S DISTINCTION BETWEEN CHANGE AND ACTIVITY

ABSTRACT. Aristotle's conception of being is dynamic. He believes that a thing is most itself when engaged in its proper activities, governed by its nature. This paper explores this idea by focusing on *Metaphysics* Θ, a text that continues the investigation of substantial being initiated in *Metaphysics* Z. Q.1 claims that there are two potentiality-actuality distinctions, one concerned with potentiality in the strict sense, which is involved in change, the other concerned with potentiality in another sense, which he says is more useful for the present project. His present project is the investigation of substantial being, and the relevant potentiality is the potentiality for activity, the full manifestation of what a thing is. I explore Aristotle's two potentiality-actuality distinctions AND argue that the second distinction is modeled on the first, with one crucial modification. Whereas a change is brought about by something other than the object or by the object itself considered as other (as when a doctor cures himself), an activity is brought about by the object itself considered as itself. This single modification yields an important difference: whereas a change leads to a state other than the one an object was previously in, an activity maintains or develops what an object already is.

1. THE PROBLEM OF SUBSTANCE

Why is primary substance problematic? Against Plato Aristotle insists that being is not a genus.¹ On Aristotle's view there are various sorts of beings, and substance (οὐσία) is the primary sort. Other beings, such as qualities and quantities, are determined as what they are in some relation to it.² To understand those other entities, then, one must first understand the being of substance. To judge from Aristotle's *Categories*, this project seems relatively straightforward. Substances are autonomous individuals, such as a particular man or a particular horse, and they are the subjects for various properties, including qualities and quantities, which are located in one or another of the nonsubstance categories. Nonsubstances depend for their existence on the substance to which they belong. The primary substances are themselves individuated by the so-called secondary substances, the species and higher kinds that classify the individuals. Although species and genera determine the primary substances as what they are, the secondary substances, like the nonsubstances, depend for their existence on the primary substances. Remove the primary substances and everything else is



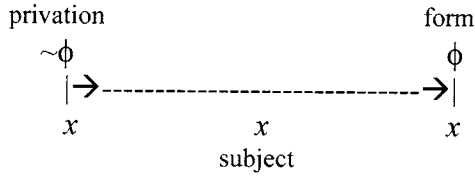


Figure 1. The replacement model of change (*Physics* I.7).

removed as well.³ Physical objects are primary substances because they are the ultimate subjects. All other things depend on them for their existence.

The problem with this picture is that it fails to accommodate substantial change. The Presocratic philosopher Parmenides had denied the possibility of all change, arguing that change would require the emergence of something from nothing. Aristotle agreed with his predecessor that there is no absolute becoming. But he regarded the existence of change as empirically evident. His task was to account for change without admitting sheer emergence. In *Physics* I.7 he proposed that every change involves three principles: a form (ϕ), an opposed privation ($\sim\phi$), and an underlying subject (x). This account of change is known as the Replacement Model. (See Figure 1).

A change is the emergence of something new, because the form (ϕ) replaces the privation ($\sim\phi$). The change is not a sheer emergence, because some part (x) of the product (ϕx) was there all along, characterized first by the privation and then by the form. For example, when Socrates comes to be musical from being unmusical, Socrates himself survives the change and is characterized first as unmusical and later as musical. The *Categories* accommodates nonsubstantial changes, changes of quality, quantity, or place. In that work Aristotle claims that a distinctive feature of a primary substance is that one and the same individual can survive the replacement of opposed nonsubstantial properties.⁴

But substantial generation and destruction cannot be so easily reconciled with the *Categories*' scheme. In a substantial generation, a substance is the *product* of a change and so cannot be what persists through it. Aristotle's Replacement Model is supposed to provide for this case too, though that provision will entail an ontological scheme more complicated than that envisaged in the *Categories*. A new substance emerges from something else without sheer emergence, because a part of the preexisting item survives in the product. Aristotle calls the continuant *matter*. Matter provides continuity between the preexisting object and the product, and guarantees that the emergence is not from nothing. When a new substance comes into being, the form, which replaces a privation, determines what the emergent substance is. Whereas substances in the *Categories* were treated as simple

entities, the analysis of change in the *Physics* reveals them as complex, as *composites* of matter and form.

Now that physical objects are regarded as hylomorphic complexes, what counts as primary substance and on what grounds? These questions are explored in the central books of the *Metaphysics* (ZHΘ). Is the whole complex primary? The complex consists of more basic components, the form and the matter, and so is arguably posterior to them (Z.3, 1029a30–32). Is primary substance the matter (Z.3, 1029a10–27)? Consider a bronze statue, whose matter is bronze. The shape of the statue informs the bronze, and the bronze can survive its removal. The constituent matter seems to satisfy the subject-criterion for substantiality in the *Categories*. If we accept the substantiality of the bronze on grounds of its subjecthood, however, why stop here? The bronze is itself a composite of more basic material ingredients, copper and tin. And these metals are themselves composites of the Aristotelian elements earth and water combined in certain ratios. Why not suppose that the elements are substances, or perhaps some yet more ultimate matter that underlies them? Tradition attributes to Aristotle a belief in prime matter, an ultimate stuff that is nothing in its own right but underlies all material bodies in the sublunary realm. Is some such ultimate matter substance? In *Metaphysics* Z.3 Aristotle excludes such an entity as substance, saying that a substance must be some definite thing in its own right (α τόδε τι) and be separate (χωριστόν) from other things (1029a26–30). An ultimate bare matter satisfies neither of these two conditions. Z.3 shows that if we press the subject criterion for primary substance, we end up with an unknowable object. Such an object is disqualified as substance because it fails to meet the constraints of thisness and separation.⁵

Is primary substance, then, the form of the composite (Z.4–12)? Whereas matter appears to claim existential priority because the form depends for its existence on it, the form appears to claim logical and epistemic priority because it determines the composite as the thing that it is and thus accounts for its knowability. Many scholars think that in the *Metaphysics* Aristotle awards the title ‘primary substance’ to form, revising the position he advocated in the *Categories*.⁶ This solution too is problematic. First, if form is primary substance, what becomes of the subject criterion and the demand that substance be capable of separate existence? Form is predicated of matter and depends on matter for its existence. Second, what becomes of the demand that substance be an individual? Form is something predicatable, definable, and knowable, and therefore seems to be a universal.⁷ It can also be shared by more than one individual (Z.8, 1034a5–8). In *Metaphysics* Z.13 Aristotle notoriously argues that no universal is a substance. Some advocates of form argue on the basis of Z.13

MARK H. BICKHARD

PROCESS AND EMERGENCE: NORMATIVE FUNCTION AND REPRESENTATION

ABSTRACT. Kim's argument appears to render causally efficacious emergence impossible: Hume's argument appears to render normative emergence impossible, and, in its general form, it precludes any emergence at all. I argue that both of these barriers can be overcome, and, in fact, that they each constitute reductions of their respective underlying presuppositions. In particular, causally efficacious ontological emergence can be modeled, but only within a process metaphysics, thus avoiding Kim's argument, and making use of non-abbreviatory forms of definition, thus avoiding Hume's argument. I illustrate these points with models of the emergent nature of normative function and of representation.

1. BACKGROUND

Tensions between naturalism and normativity are of ancient provenance. We can find them, for example, in Plato and Aristotle's analogy between perception and the impression left by a signet ring in wax: Wax impressions are factual; How do they acquire the normativity of representational content? How could they represent falsely?

With Descartes, such tensions become expressed in a fundamental metaphysical split between two kinds of substances, one of the factual, non-normative world, and one of the mental, normative (and intensional) world. Some, such as Hobbes, attempted to account for the world only in terms of the factual realm, and Hume argued that the normative could not be recovered from strictly factual, empirical, grounds – 'ought' could not be derived from 'is'.

This diremption between fact and norm has been generally accepted since Hume, sometimes yielding an anti-naturalism, such as with Kant and Frege, and sometimes yielding an anti-normative naturalism, as with Quine. In any case, we seem to be faced with a small set of unattractive alternatives: (1) an anti-naturalistic dualism of fact and norm, (2) attempting to account for the world with a pan-normative idealism, (3) a rejection of normativity yielding an identification of naturalism and physicalism. Kant introduced the two realm, fact and norm, framework in reaction to Hume,¹ and logical positivism was the last failed attempt at making good



on this approach. Idealisms are not prominent in today's scene, but remain a temptation, even if hidden, such as in some versions of contemporary linguistic idealism. The austere rejection of normativity in favor of a strictly factual world has become the dominant contemporary view since Quine, though it is seldom realized how deeply this fails to account, *scientifically* account, for normative, mental, phenomena.²

There is a fourth possibility: naturalistic emergence. If norms were emergent from non-normative phenomena, that could unify the factual and normative world, thus transcending the trilemma. But ontological emergence encounters serious problems, so serious that they have been taken to be fatal by many, if not most. Nevertheless, I argue that emergence is the required dissolution of this aporia, but that an acceptable model of emergence itself requires fundamental shifts elsewhere. In particular, it requires a shift from a substance or particle metaphysics to a process metaphysics.

1.1. *Process and science*

This shift has strong historical support. Every science has passed through a phase in which it considered its basic subject matter to be some sort of substance or structure. Fire was identified with phlogiston; heat with caloric; and life with vital fluid. Every science has passed beyond that phase, recognizing its subject matter as being some sort of process: combustion in the case of fire; random thermal motion in the case of heat; and certain kinds of far from thermodynamic equilibrium systems in the case of life.

The exception to this historical pattern are sciences and philosophies of mind. Mind is still approached from within a substance and structure framework of background presuppositions. This is well illustrated with the case of representation: perceptual representations are construed, for example, as consisting of transduced encodings of the light in the retina, but this process of 'transduction', and how it could yield normative representations, is just as mysterious in this technologically updated version of wax impressions as it was in the original. The account, that is, is still caught in the strictly factual, and cannot account for normativity.³

2. CHALLENGES TO EMERGENCE

I will address and critique two fundamental challenges to emergence, one metaphysical and one logical. These challenges, I argue, are fundamental and valid, but unsound. In fact, diagnosing them yields two basic false assumptions which, when corrected, point the way toward a legitimate approach to emergence. Within this metaphysical and logical framework,

then, I address two primary forms of normative emergence, function and representation.

2.1. *Metaphysics: Particles and process*

New substances cannot emerge. Only combinations or organizations are possible. Furthermore, if all is substance, or, in its contemporary atomistic form, if all is particles, then all causal power is resident in that basic substance or particle level. In particular, there is no emergent causal power.

Kim (1989, 1990, 1991, 1992a, b, 1993a, b, 1997) has developed these basic points into a subtle and sophisticated argument against emergence. In effect, his arguments pose a dilemma: either naturalism is false, or genuine emergence does not exist:

- If higher level phenomena are not supervenient on lower levels, then we have some sort of dualism and naturalism is false.
- If higher level phenomena *are* supervenient, then all causality is resident in the lowest level supervenience base of fundamental particles, whatever they may turn out to be. In particular, no genuine higher level causal powers can be emergent. All causality is located in the fundamental particles.⁴

In this view, higher level causal regularities are just the working out of the causal dance of the particles within whatever configuration they have with each other. Higher level organization, which is the usual purported locus for emergent causal power, is merely the stage on which the basic particles engage in their causal interactions. Therefore, all higher level phenomena are causally epiphenomenal, and causally efficacious emergence does not occur.⁵

The crucial center of this argument depends on the fact that particles participate in organization, but do not themselves have organization. Thus, the presumed locus of causal power, in this framework, is something that has no organization. Consequently, organization is not a legitimate locus of causal power. The emergence assumption that new causal power can emerge in new organization would require breaking the monopoly of causal power that is held by things that have no organization.

There is, however, a strong rejoinder to this argument: there are no particles. First, a pure particle metaphysics has serious coherence problems because dimension zero particles would have zero probability of ever encountering each other. Worse (for a particle model), however, is that our best contemporary physics argues that there are no particles (Brown and Harré 1998; Cao 1999; Davies, 1984; Huggett, 2000; Saunders and Brown 1991; Weinberg, 1977, 1995, 1996, 2000). Instead, everything is quantum fields. What appear as particle interactions are instead quantized