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# A Natural Case for Realism: Processes, Structures, and Laws

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A Natural Case for Realism: Processes, Structures, and Laws

by

Andrew Michael Winters

A dissertation submitted in partial fulfillment  
of the requirements for the degree of  
Doctor of Philosophy  
Department of Philosophy  
College of Arts and Sciences  
University of South Florida

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## DEDICATION

*For Amie*

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## ABSTRACT

As the burgeoning field of metaphysics of science indicates, there is a close relationship between metaphysics and science. In this dissertation, I show how both metaphysical and scientific considerations inform our understanding of processes, structures, and laws of nature. In particular, I argue that a naturalistically informed metaphysics provides a foundation for assessing contemporary ontologies. This foundation serves as a point of entry for critiquing substance-based ontologies and providing justification for the claim that an ontic structural realist should adopt a process framework in developing an account of laws.

Chapter 1 considers the extent to which the sciences' own attempts to understand reality provide reasons for developing a naturalistically informed metaphysics consistent with methodological naturalism. I maintain, however, that previous formulations of methodological naturalism are too stringent and that an *attenuated* methodological naturalism is preferable for the purposes of assessing metaphysical theories.

Chapter 2 then sets out to assess the status of contemporary ontologies by taking into account neo-Aristotelian substance metaphysics. After discussing some of the similarities between Aristotle's and contemporary neo-Aristotelians' accounts of SUBSTANCE, I take issue with Lowe's theory of SUBSTANCE as he develops it in the context of his four-category ontology. Like the majority of neo-Aristotelians, Lowe's account relies heavily upon common sense. This reliance, however, turns out to pose difficulties for his account of SUBSTANCE since common sense is insufficient for providing an account of how medium-sized objects change and establishing what are taken to be necessary features of substances.



Given the developments of Chapter 2 and implementing the attenuated methodological naturalism developed in Chapter 1, Chapter 3 considers the extent to which neo-Aristotelian substance metaphysics can benefit from naturalistic considerations. In particular, I consider developments from quantum field theory in physics and the extended synthesis in biology to assess the status of a theory that incorporates substances understood as being ontologically fundamental, independent, and non-relational. These considerations illustrate how a neo-Aristotelian substance metaphysics is not vindicated by these specific naturalistic developments. Furthermore, since neo-Aristotelian metaphysics is the canonical formulation of a substance-based metaphysics, we can generalize these findings to claim that contemporary naturalistic developments will likely pose difficulties for most substance-based views.

Whereas Chapters 2 and 3 are mostly critical of substance-based metaphysics, Chapter 4 develops a positive defense of process metaphysics. Although process metaphysics has been dismissed, for what appear to be mostly appeals to tradition and associations with theological interpretations of Whitehead, I argue that the naturalistic considerations that challenge substance-based views can provide positive support for process metaphysics of the form developed by Seibt.

Chapter 5 further provides reasons for pursuing process metaphysics by developing a process account of *structure*. In doing so, I first consider how neo-Aristotelians have made positive contributions to our intuitive understanding of structures, but that these accounts are ultimately problematic. I then offer a positive account of structures in terms of metastable processes, which I argue are capable of accommodating our intuitions and overcoming the difficulties facing the neo-Aristotelian account.

Chapter 6 further implements the account of structure developed in Chapter 5 to argue that the ontic structural realist can adopt a process framework. The adoption of a process framework is itself a result of suspending judgment on the status of substance metaphysics for similar reasons to ontic realists such as Ladyman who also reject neo-Scholastic metaphysics. Both process metaphysicians and ontic structural realists have additional commonalities in their attempts to develop a monocategorical ontology—the processist develops an ontology solely in terms of processes while the ontic structural realist offers an ontology that only makes use of structures. Given these commonalities and the process account of structure, I argue that an ontic structural realist can adopt a general process framework. This has the added benefit of allowing the ontic structural realist to overcome limitations of having constrained metaphysics to physics.

The final chapter, Chapter 7, provides a sketch of how the project of developing an ontic structural realism within a process framework can accommodate an account of laws of nature. In particular, modal and causal relations are asymmetrical relations. I argue that since it is not clear how the addition of laws to symmetries provides an adequate account of these relations, thinking of laws of nature from within a process framework can provide some insights to how these asymmetrical relations can both be a result and cause of symmetrical relations, thereby suggesting that the ontic structural realist should adopt a process framework.

## CHAPTER 1: ATTENUATED METHODOLOGICAL NATURALISM

### 1.0 Introduction

There is much disagreement on the appropriate methodology for doing metaphysics.<sup>1</sup> As Wilson suggests, these disagreements are the source of many disputes (Wilson 2014, 150). Without a definitive research program in place, it is understandable why there is little agreement on the appropriate method.<sup>2</sup>

My aim in this chapter is to develop and defend a form of methodological naturalism, which holds that we should allow metaphysical theories to be defeasible in light of scientific claims, but we should not immediately assess those metaphysical theories as being false given defeater instances. In arguing for this methodology, I will first address the sense in which I am advocating ‘suspending judgment’ (1.1). This sense of ‘suspending judgment’ will then allow me to assess Papineau’s own account of judgment suspension as being too stringent in light of the general aims of metaphysics (1.2). I will then discuss the relationship between the development of scientific concepts and *a priori* concepts (1.3), which will allow me to explore implications for the general relationship between metaphysics and the sciences (1.4).

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<sup>1</sup> See Haug (2014) and Chalmers et al. (2009).

<sup>2</sup> Although I am centrally concerned with metaphysics, much of what I say is applicable to philosophy in general. In particular, my concern with establishing a methodology for metaphysics has overlap with my concerns with philosophical methodology.

## 1.1 Suspending Judgment

The initial reason for not wanting to recommend that metaphysical theories are falsified by scientific data is that the mere admission of falsity can prevent further development or pursuit of those theories. At best a false theory may still be understood as being a “useful fiction” (e.g., Newtonian mechanics).<sup>3</sup> But if our concern in doing metaphysics is to understand reality itself, then usefulness is not particularly useful; usefulness only provides insight to the aims and values of the community members who treat a theory as being useful.

Rather than assessing those metaphysical claims that conflict with scientific claims as being false, we should suspend judgment with respect to their truth-values. This is in line with Pollock’s account of *undercutting defeaters* in which new evidence results in the questioning of the connection between some set of evidential claims and their respective conclusion (Pollock 1992, 3).<sup>4</sup> Pollock argues that becoming aware of the possibility that environmental factors (e.g., light) can alter how things appear (e.g., being red) results in suspending belief to the claim that something is red simply because it appears red. The introduction of the possibility that environmental factors can alter the appearance of objects without altering the objects themselves, however, does not refute the belief that an object is red. Instead, it prompts further investigation into the nature of perception, objects, and light. Whereas we may no longer state that something is red because it appears as such, we also would not be justified in saying that it is false that something is red because of the possibility that the light is altering the appearance of the object. In other words, we should suspend judgment to the claim of that an object is one particular color, but should not reject the claim that the object is that color. This act of suspending judgment

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<sup>3</sup> See Field’s (1989) discussion of how mathematics is to be understood as a useful fiction.

<sup>4</sup> Thanks to John Carroll for bringing this point to my attention.

allows for the further possibility that scientific claims are themselves false, a possibility consistent with criticisms of scientific realism (e.g., *pessimistic meta-induction*). In such a case, the dismissal of a metaphysical claim will turn out to be unjustified (assuming that the scientific claim was the *only* reason for rejecting the metaphysical claim in question).

Suspending judgment also allows a metaphysical claim to be further developed. Doing so may result in the claim being beneficial (in terms of how we end up defining ‘beneficial’) to some future science. There is also the lingering possibility that our reasons for thinking that a metaphysical claim conflicts with the scientific data are mistaken. Additional development of a metaphysical claim may indicate that it turns out to be consistent with the data that resulted in its initial dismissal. This recommendation to suspend judgment while further exploring the implications of a claim is also consistent with much of scientific practice in which competing claims are pursued despite their conflicts; whereas the way(s) a claim will be pursued, however, will depend upon the way(s) in which the claim conflicts with the currently available data.<sup>5</sup>

## 1.2 Papineau’s Formulation

This formulation of methodological naturalism has much in common with Papineau’s formulation, in that “Methodological naturalism asserts that philosophical investigation is like scientific investigation” (Papineau 2014, 166). His sketch of the relationship between philosophy and science consists of three parts:

1. Claims made by science are synthetic, not analytic.
2. Philosophical knowledge is *a posteriori*, not *a priori* since philosophical claims depend upon the same kind of empirical support as scientific theories.

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<sup>5</sup> In many ways, this recommendation to suspend judgment is in line with Feyerabend’s (1975) *Against Method* in which he argues for *theoretical anarchism*.

3. Central questions of philosophy concern *actuality* rather than *necessity* since the actual world is studied by science.

Each of these claims, however, is contentious and results in overly rigid constraints on what appropriately counts as a significant philosophical project. For this reason, my account of methodological naturalism will be a refinement of Papineau's.

First, the focus on synthetic claims and not analytic claims depends upon an initial assumption about philosophy and what counts as being significant to philosophy. This assumption is elicited by Papineau's refutation of Jackson's (1998) discussion of analytic truths in which he states that "*even if* there are analytic truths of just the kind that Jackson supposes, they are of no significance to philosophy" (Papineau 2014, 174; emphasis in original). This statement, however, is problematic. What counts as significant will depend upon our initial understanding of what philosophy is. If someone maintains that philosophy involves conceptual analysis, the activity of assessing analytic truths will itself be significant. Similarly, if someone adopts the stance that philosophy is like science in that it is not engaged in the activity of assessing concepts, then analytic truths will not have philosophical significance. (I will have more to say on this in a moment.)

Papineau's resistance to allowing analytic truths to play a significant role amounts to his resistance in allowing concepts to play a significant philosophical role. He writes,

Concepts themselves set no philosophical agendas. They are ontologically non-committal. The mere possession of concepts carries no implications at all about the contents of reality, and so cannot point the way to further investigations of reality in the way that substantial synthetic claims can. (Papineau 2014, 174)

This passage is problematic since not only is a philosophical agenda dependent upon our understanding of philosophy, but the users of concepts *do* make ontological commitments in their assessment of the truth-values of statements in which instances of concepts occur. For example, an utterance of the form “it is true that  $x$  is a dog” indicates some commitment to there being a concept  $DOG$  and the existence of something in the world that is taken to be a dog.

Even though I disagree with Papineau’s portrayal of the role concepts play in informing our investigations of reality, I do agree that the possession of a concept on its own carries no implications at all about the contents of reality; having a concept of  $x$  does not mean that  $x$  exists. The possession of a concept does, however, have implications for our abilities to make sense of reality and the development of methods for inquiring into its nature. In the case of having the concept  $DOG$ , a person is more inclined to investigate aspects of various canines (presuming the person has the relevant concepts for such investigations) that provides guidelines for constructing taxonomies and additional clarifications with respect to theories about dogs.

### 1.3 Scientific Concepts

Using concepts as a starting point to inquiry is particularly evident in cases involving scientific concepts. The assessment of a scientific concept is also the assessment of the theory that the concept shows up in. For example, the concept  $ELECTRON$  shows up in atomic theory. Comparing the concept to the empirical data informs our understanding of both the concept and the role that electrons have in atomic theory. Conceptual analysis, at least of the form advocated by Jackson (1998), appears to take a similar form, where concepts are able to be refined in accordance with the refinement of the very intuitions that resulted in the initial formulation of the concept. Jackson writes,

Our account sees conceptual analysis as an empirical matter in the following sense. It is an empirical fact that we use a certain term for the kinds of situations and particulars that we do in fact use it for, and the conclusions we come to on the subject are fallible... We also noted that conceptual analysis in our sense is of a kind with what cognitive psychologists do when they investigate the young child's concept of *faster than*, and political scientists do when they investigate different voters' concept of *socialist*, and these are, of course, empirical investigations. (Jackson 1998, 47)

Jackson goes on to discuss the ways in which conceptual analysis is also understandably an *a priori* endeavor, but it is important, at this point, to acknowledge how conceptual analysis is tied to empirical issues through the connections existing between the concepts and the theories that they show up in.<sup>6</sup>

Second, this connection between conceptual analysis and empirical investigation highlights how focusing exclusively on the *a posteriori* ignores many aspects of the relationship between science and philosophy. As in the case of the concept ELECTRON, many of our concepts originate from science. But not all concepts from one scientific field, say physics, will be of concern to all philosophers. For example, philosophers of biology are likely to be more interested in concepts that originate (e.g., SPECIES) from the life sciences. Furthermore, the establishment of these concepts, as informed by the sciences, will play a significant role in informing the

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<sup>6</sup> Someone might press this issue and ask if this is really conceptual analysis any longer. This would take the discussion too far afield. My present purpose is only to show that Papineau's attack on analytic truths is misguided.



metaphysical theories that undergird the concepts themselves.<sup>7</sup> In particular, a concept from physics (e.g., FIELD) may come into conflict with some concept from biology (e.g., SPECIES). The metaphysician, then, would have the task to assess and attempt to clarify why the inconsistency occurs given that the two concepts deal *prima facie* with two different aspects of reality—presuming that reality is itself unified. By analyzing the concepts, the metaphysician is then in a better position to resolve the inconsistency.

So far, though, this only highlights how the analysis of some concept is beneficial only when it deals with matters dealing with scientific theories. Consistent with my recommendation that we should not evaluate metaphysical claims that are at odds with scientific claims as being false, we should not state that a metaphysical project is philosophically significant only when it is tied to a synthetic theory. To do so would require a determination of when a metaphysical theory should be accepted, which my account is unable to do in its current formulation. At this point, I can only say when we should not dismiss a metaphysical theory as being false. The above discussion does, however, provide some insight to how metaphysics and science are distinguishable yet capable of informing one another without being reduced to each other.

Third, in suggesting that the philosophical pursuit of necessity is at odds with scientists' investigations of the actual world ignores how much of science is itself concerned with necessity (in its pursuit of identifying universal laws) and possibility (in its exploration of dispositional properties). Furthermore, the philosophical pursuit of necessity is not interested in what is possibly necessary, as an attempt to identify what is necessary in some other *possible world*, but to identify what is actually necessary—that is, philosophical discussions of necessity *do* attempt to identify what must be the case in the actual world.

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<sup>7</sup> I am here assuming that scientific theories are dependent upon metaphysical theories. This is consistent with claims made by Lowe (2006).

It appears, then, that Papineau undersells the philosophical sense of *modality* and its metaphysical significance without acknowledging how it is very similar to the scientist's own investigations. In particular, he overlooks how thought experiments and other speculative armchair methods are aimed at clarifying aspects of the actual world. He can accommodate this interpretation, though, since he does not dismiss armchair methods *per se*, and he also recognizes that scientists engage in similar methods (Papineau 2014, 167). This is a point for which Paul (2012) also argues. The difference, however, between Papineau, Paul, and myself and proponents of using analytic introspective methods is that these proponents allow conceptual analysis, thought experiments, and intuitions to provide evidentiary support. In many cases (e.g., Bealer (1998)) the use of these types of evidence are what allow philosophy to maintain its autonomy. These approaches, however, have continuously come under scrutiny (See Cappelen (2012)). On the account of methodological naturalism I offer here, conceptual analysis, thought experiments, and intuitions are still useful tools for engaging in metaphysics. The difference, however, is that these are junctures for investigation, rather than confirmation for some metaphysical claim.

#### **1.4 Implications**

Despite the commonalities between my own formulation of methodological naturalism and Papineau's, his account on the whole is too stringent in requiring philosophy to follow the aims and methods of science. This is limiting because there may be a point at which philosophy and science do become quite different and there is a good case made for the autonomy of philosophy. It would be suspicious not to allow for such arguments to go through if they entail the independent development of philosophy. Furthermore, the possibility of scientific methods radically changing makes me hesitant to suggest that philosophy should be constrained to the

methods of current science if the only reason that we would have to change philosophical methodology would be due to scientific methodology changing.

These possibilities highlight the main differences between Papineau's and my own formulation of methodological naturalism; whereas Papineau's account is a positive formulation of what the aims of philosophy should be, my account is a negative formulation of what methods we should use for dismissing metaphysical claims. At this point, I don't think that Papineau would disagree with my formulation. I do believe, though, that he would disagree with my assertion that metaphysical claims that are at odds with scientific claims should not automatically be evaluated as being false.

My formulation, however, is preferable since it acknowledges the blurred boundaries between metaphysics and science in allowing them to inform one another without indicating that they constrain each other. Furthermore, as Papineau indicates, there is much of philosophy that naturalists have been unable to provide adequate explanations for (e.g., normativity, logic, and mathematics). By allowing metaphysicians to continue pursuing these areas despite the lack of thorough naturalistic explanations, metaphysicians still have reasons to pursue these topics. This is something that my account allows room for; it does not require the metaphysician to stop pursuing these topics once she sees that her account is at odds with the best currently available scientific data. For these reasons, my account of methodological naturalism is more lenient than Papineau's assessment of what counts as being philosophically significant, but is also more powerful in that it allows us to further pursue traditional philosophical topics—topics that do not appear to be going away anytime soon.

## 1.5 Conclusion

In this chapter I have argued that an attenuated formulation of methodological naturalism is preferable to Papineau's formulation, since my account allows us to continue pursuing traditionally significant projects in metaphysics without having to acknowledge them as being true. This formulation has been developed from an observation about the relationship between metaphysics and science and how they are capable of informing one another without being reduced to each other.

The upshot of having developed a defense of a method for engaging in metaphysics is that we can now begin assessing specific metaphysical theories. In assessing which metaphysical theories we should adopt, I first consider substance-based metaphysics of the form espoused by neo-Aristotelians before considering process-based metaphysics. My reason for evaluating substance metaphysics first is due to it being the traditional and contemporarily the "received view" in metaphysics. By showing that there are reasons for questioning the mainstream position, we gain further motivation for considering other peripheral metaphysical theories, which, for the purposes of the remainder of the dissertation, will be process-based metaphysics.

## CHAPTER 2: THE PRIMA FACIE IMPLAUSIBILITY OF SUBSTANCE

### 2.0 Introduction

As the previous chapter illustrates, many metaphysicians take themselves to be engaged in projects that involve discovering the most fundamental or general facts of reality. Among these projects are attempts to understand the most fundamental categories. This is a project with which Aristotle concerned himself (Aristotle 1984). Among these categories SUBSTANCE is taken to be among those that are most fundamental. The emphasis on SUBSTANCE has led many philosophers to develop what can be characterized as *substance metaphysics*—that branch of metaphysics that understands reality to be fundamentally comprised of discrete countable substances. In answering the ontologist’s question of how many things exist, the substance metaphysician will respond with an account of the number of substances.

Although we can identify Aristotle as being one of the founders of substance metaphysics, substance metaphysics is not merely a relic of antiquity. Instead, we can understand substance metaphysics to be the “received view” among metaphysicians. In particular, there has been a recent surge of metaphysicians appropriating Aristotle’s projects to develop what is called *neo-Aristotelian metaphysics*.<sup>8</sup> These neo-Aristotelians adopt the substance framework in understanding the fundamental categories of existence. In doing so, they have made substantial contributions to our understanding of *substance* and *structure*. Despite these contributions,

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<sup>8</sup> See Tahko (2012).

however, there remain reasons for questioning the key components of neo-Aristotelian metaphysics.

The current chapter will focus on Lowe's (2006) account of *substance*, while Chapter 5 will provide an assessment of the neo-Aristotelian account of *structure* that Simons (1989) develops. The main idea that I will address for the present chapter is Lowe's treatment of SUBSTANCE as being the most general and fundamental of the ontological categories. Although there are disagreements among neo-Aristotelians regarding the number of ontological categories, most neo-Aristotelians are in agreement with Lowe that substance plays a significant role in developing a neo-Aristotelian metaphysics. By drawing out the implausibility of Lowe's account of substance, we are then in a better position to warrant the suspension of belief with respect to the neo-Aristotelian account of substance. Since neo-Aristotelianism can be assumed to be the currently best formulation of substance metaphysics, the suspending of judgment to neo-Aristotelian accounts of substance warrants suspension of judgment to substance metaphysics.

The main difficulty with Lowe's account is that he adopts the neo-Aristotelian method of using common sense as a starting point for establishing metaphysical theories. The adoption of this method results in Lowe being ensnared in results that are insufficiently supported by common sense. In particular, Lowe's substance metaphysics is found to be implausible when we consider how his account of substance is unable to accommodate our commonsense intuitions of what an adequate account of change should possess. Furthermore, the key, interrelated attributes of substance, being that substance is taken to be ontologically fundamental, independent, and non-relational, are dependent upon assumptions that lack sufficient support from common sense.

In arguing that Lowe's substance metaphysics is implausible, the plan for this chapter will be as follows: After first discussing some of the similarities between the Aristotelian and neo-Aristotelian accounts of SUBSTANCE (2.1), I will specifically discuss Lowe's theory of SUBSTANCE in the context of his four-category ontology (2.2). I will then discuss some general issues with his account by first observing how his account of substance fairs when considering commonsense observations about medium-sized objects and how they undergo change (2.3). The second issue I will address concerns the features of substance that are taken as necessary, but lack support from common sense (2.4). The chapter will conclude with a brief discussion of why the neo-Aristotelian should not place such a strong emphasis on common sense as a method for developing metaphysical theories about substance. The upshot being that the neo-Aristotelian will want to also consider naturalistic developments; in evaluating if such developments will be of assistance to the neo-Aristotelian, as I will argue in Chapter 3, the answer is "no."

## 2.1 Neo-Aristotelianism and Substance

Neo-Aristotelians take their lead from Aristotle's own development of metaphysics, or *first philosophy*, in pursuing the questions *What is being?* and *What is substance?* (Aristotle *Metaphysica Z I*, 1028b2-4). In particular, Lowe (2006a) treats first philosophy as being the "science of essences." *Essences*, however, for neo-Aristotelians, depend upon substances. By assessing the metaphysical status of substances, we can, in effect, assess the general tenability of neo-Aristotelian metaphysics.

What counts as a *substance* is contentious, which is partly a result of Aristotle's own account of substance being unclear. As Gill indicates, there are at least three issues with Aristotle's account that prevent the development of a cohesive account of substance (Gill 1991, 127). First, it is unclear what the relation is between substance and matter. Specifically, it is

unclear if matter is distinct from substance or if substances are capable of being proper parts of other substances when Aristotle writes, “If then matter is one thing, form another, the compound of these a third, and both the matter and form and the compound are substance, *even the matter is in a sense called part of a thing, while in a sense it is not*, but only the elements of which the formula of the form consists” (*Metaphysics Z*, 1035a-4; emphasis my own). Second, it is not obvious in Aristotle’s *Metaphysics* if matter is taken to be part of the form of something when he states that “For the form, or the thing as having form, should be said to be the thing, but the material element by itself must never be said to be so” (*Metaphysics Z* 1035a5-9). Third, there is further confusion in understanding Aristotle’s account of substance insofar as it not clear whether substance is prior or posterior to a thing: The “parts which are the nature of matter, and into which as its matter a thing that is divided are posterior; but those which are the nature of parts of the formula, and of the substance according to its formula, are prior, either all or some of them” (*Metaphysics Z* 1035b11-14).

I do not intend to clarify Aristotle’s account, nor will I provide commentary on the debates of how to appropriately interpret Aristotle. My purpose for addressing these points is to illustrate how there should be little surprise in the lack of a cohesive account of substance given our difficulties in understanding Aristotle’s own formulation. More importantly, though, these difficulties prevent the neo-Aristotelian from simply appropriating Aristotle’s own formulation. If the neo-Aristotelian conception of substance “is one that is an extension of and / or is in imitation of Aristotle’s views about substance” (Hoffman 2012, 140), and Aristotle’s account of substance is unclear, then the neo-Aristotelian will need to clarify both hers and Aristotle’s meanings of ‘substance’. Towards this aim, Hoffman (2012) offers seven characteristics of Aristotle’s account of substance:



1. Category of SUBSTANCE is neither eliminable nor reducible to any other category.
2. Substances are ontologically fundamental, basic, or primary.
3. Substances are not defined in terms of relations.
4. The category of SUBSTANCE is the widest scheme of ontological categories.
5. Method: Start from common sense and the theory about substances should most closely conform to common sense.
6. SUBSTANCE is itself an analyzable concept.
7. Substances have ontological independence.

Although all of the above characteristics are in some way shared by neo-Aristotelians, 2, 3, and 7 appear to be the most commonly shared traits with respect to providing an account of substance. Regarding methodology, 5 indicates the role that common sense serves neo-Aristotelians in formulating their metaphysical accounts.

Hoffman suggests, however, that it is not necessary for the neo-Aristotelian to uphold the view that substances are ontologically independent (Hoffman 2012, 147). This suggestion, however, is at odds with his own account of substance: “By a substance, I mean an *individual thing or object*, and not merely a quantity of stuff” (Hoffman 2012, 140 n.1; emphasis my own).<sup>9</sup> Hoffman’s recommendation that it is not necessary for the neo-Aristotelian account to require that substances be ontologically independent is a response to Aristotle’s own difficulties in providing a cogent case for the ontological independence of substance (as evinced by the above passages from *Metaphysics Z*). But simply because something is difficult to reconcile with an

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<sup>9</sup> Not all neo-Aristotelians agree on what counts as a member of the category SUBSTANCE. For example, while Lowe (1998) divides substances in terms of *stuffs*, *organisms*, and *artifacts*, Hoffman (2012) divides substances in terms of *soul* and *body*.

account does not mean it is not significant (or even necessary) to properly understanding that account.

Furthermore, many neo-Aristotelians would disagree with Hoffman. As Hoffman is aware, “many neo-Aristotelians have attempted to improve the case for the independence of substances” (Hoffman 2012, 147). The reason that many neo-Aristotelians have made these attempts is due to them agreeing with Lowe in understanding substance as being ontologically independent. First, Lowe understands metaphysics as being concerned with studying “the most fundamental structure of reality” (Lowe 1998, 2). Second, what is most fundamental is substance: “A substance ontologist certainly does not take states of affairs to be the basic building blocks of reality: rather, it is *substances*, of course, that are taken to have this status” (Lowe 2006, 109; emphasis in original). Last, Lowe provides insight to what is most significant for the neo-Aristotelian’s understanding of substance. He writes, “And what is a substance? Well, that is a very long story, as long indeed as the history of western philosophy. But, without a doubt, one of the key ideas in the notion of substance is the notion of *ontological independence*” (Lowe 2006, 109; emphasis in original). Given Lowe’s comments, despite Hoffman’s suggestion that ontological independence is not necessary for the neo-Aristotelian’s account of substance, many neo-Aristotelians follow Lowe in maintaining that an adequate account of substance requires substances being ontologically independent.<sup>10</sup> For these reasons, it is not a misconstrual of neo-Aristotleans’ accounts of substance, including Hoffman’s, to state that their account involves substances being ontologically independent.

Less contentiously, in addition to substances being ontologically fundamental and independent, neo-Aristotelians understand substances as being non-relational. In adopting an

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<sup>10</sup> Lowe goes on to state that “it may be agreed by all substance ontologists that, in some suitable sense of ‘ontologically independent’, substances are ontologically independent entities” (Lowe 2006, 109).

account of substance from Aristotle, Oderberg writes “all we need to extract from the relevant... passages where Aristotle discusses relations is his fairly clear adherence to the proposition that not everything that exists is essentially relational because *substances* are not relational” (Oderberg 2012, 211; emphasis in original). It is their nonrelational nature that allows substances to have determinant identity conditions. With this third component, we are now in a better position to identify the key interrelated components of the neo-Aristotelian account of substance.

To summarize: Neo-Aristotelians understand substances to have many shared aspects with Aristotle’s original account. Although there is disagreement as to how we should flesh out the details of ‘substance’, there are at least three shared aspects: substances are fundamental, independent, and non-relational.<sup>11</sup> Each of these aspects may be understood independent of one another, but I am not assuming that they are *necessarily* independent. For the purposes of evaluating these aspects, it is useful to allow the possibility that they are interrelated since, as I will argue below, that if something is not non-relational it is not independent, and, therefore, not fundamental.

There are at least two benefits to analyzing Lowe’s account of substance. First, as mentioned above, Lowe’s account of substance captures the main aspects of many other neo-Aristotelian accounts of substance. By assessing these attributes as they function in his account, we are also able to make general claims with respect to other neo-Aristotelian accounts of substance. In doing so, we are then in a position to critique substance metaphysics itself. Second, Lowe is concerned with his ontology providing a foundation for the natural sciences (as evinced by the subtitle of his manuscript *The Four-Category Ontology: A Metaphysical Foundation for*

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<sup>11</sup> There are some relational substances (e.g., *hand*), but these are derivative and not fundamental substances for the (neo-)Aristotelian.

*Natural Science*). Although the neo-Aristotelians already mentioned above share Lowe's interest in the relationship between science and metaphysics, Lowe is centrally concerned with this relationship. For this reason, his account is readily open to naturalistic considerations, which will serve as an entry point to my assessment of neo-Aristotelianism in light of methodological naturalism in Chapter 3. Before analyzing his account, though, I will clarify Lowe's account of substance to better understand its implausibility.

## 2.2 Lowe and Substance

Lowe (2006) develops a four category ontology, comprised of individual substances (*objects*), substantial universals (*kinds*), non-substantial universals (*properties*), and attribute instances (*modes*). Lowe understands the category of substance to be the most fundamental since it is the most general and broad (Lowe 2006, 20). The generality of the category of SUBSTANCE is a result of the categories being arranged hierarchically and distinguished by their members' existence conditions (Lowe 2006, 6), which are identifiable *a priori* (Lowe 2006, 20).

In the case of the category of substance, the existence conditions for *objects* (a term that Lowe uses interchangeably with 'substance') involves being the bearer of properties (or attributes), but not being made up of those properties (Lowe 2006, 9). Although the object's properties do not require a substratum, the properties are ontologically dependent upon the object that *exemplifies* those properties. This is the very nature of an object (substance) insofar as it exemplifies the non-substantial universal (attribute), which the property is an instance (mode). For example, a black coffee cup that appears as being black exemplifies these relations; the property of being black is itself an instance of the non-substantial universal, while the non-substantial universal is itself exemplified, but not instantiated, by the cup.

Lowe, however, does not develop an argument for how objects are able to provide support for properties or exemplify non-substantial universals. Instead, he appeals to our intuitions that result from reflecting on our observations of individual objects. He writes,

There is no mystery as to *how* individual substances can perform this ‘supporting’ role, for once we recognize the category of individual substance as basic and irreducible and the category of property-instance as correlative with it, we can see that their having such a role is part of their essential nature. Explanation—even metaphysical explanation—must reach bedrock somewhere, and this, according to the four-category ontology, is one place where bedrock is reached. The idea that some more fundamental explanation is somehow available, if only we can probe reality more deeply, is, I think, just an illusion born of ...some...confusion.

(Lowe 2006, 28; emphasis in original)

More needs to be said; it is not obvious that “there is no mystery” to why we should believe that substances are supportive in the way that Lowe describes. As I will discuss in the remainder of this chapter, his account of substance is problematic for intuitive and conceptual reasons—notably, those issues that arise in light of our commonsense understanding of the changes that medium-sized objects undergo. Without further explanation, the mystery of how substances provide foundational support remains.

### **2.3 Change and Substance**

In line with Paul (2012) one of the tasks of the metaphysician is to offer a coherent account of both the manifest and scientific images. Doing so involves offering an account of how the world is, as described by science, and an account of why the world appears as it does, given that the world described by science is often at odds with how we experience it. Among many of these

experiences of the world is that objects undergo change: people age and wooden chairs become worn and break. Yet we also take the person who ages to be the same person, in some sense, as the younger version of herself. Similarly, we do not believe that a new, broken chair is created when one breaks, but, instead, that a chair has become broken. In other words, objects appear to exhibit changes while maintaining some conditions of identity.

We can provide a sketch of the commonsense formulation of change as follows: Some entity  $e$  of kind  $E$  is said to change *iff*  $e$  has some set of properties  $P$  at  $t_1$  and then has some other set of properties  $P'$  at  $t_{1+n}$  and  $P \neq P'$  while remaining a member of  $E$ .<sup>12</sup> In attempting to offer an account of change, Lowe does not allow for the possibility of an entity to change from one fundamental category to another. “The reason for this is that ontological categories are themselves identifiable in terms of the characteristic existence- and identity-conditions of their members. But an entity cannot undergo a change with respect to its own existence” (Lowe 2004, 152). To accommodate the phenomenon of change, Lowe suggests that we make a distinction between *quantity* and *piece* of stuff. A piece can cease to exist when it is divided, but this does not result in a modification of the quantity. When a single chair breaks, its pieces cease to exist, but there is still only one chair.

Initially, Lowe’s account of change that depends upon a distinction between a quantity and piece of stuff lacks direct support from our commonsense observations of things being

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<sup>12</sup> Although there are some technical difficulties with this formalization, which I appreciate John Carroll bringing to my attention, the purpose of this sketch is to highlight that when we think of objects changing that they do not possess all of the same properties at two different times, but maintain some degree of similitude at the two different times that allows us to say that it is the same object despite it having undergone change. This account is, however, setting aside those instances in which an object undergoes such drastic change that it is no longer appropriate to say that it is the same object.

identical to their previous instantiations despite their having undergone some modification.<sup>13</sup> At what point do we no longer have the same particular chair when its wood is splintered and we divide its pieces?<sup>14</sup> Each particular chair can potentially be divided enough times so that all of its parts have undergone division at some point. On Lowe's account, after each part has undergone division, each part has been destroyed (ceases to exist).<sup>15</sup>

Furthermore, our commonsense account of change should not be at odds with the commonsense assumption that if a particular object occupies multiple spatial regions, that those regions are immediately connected. Once a chair is broken, though, it is unclear how we should assess what exists. The person who witnesses (or performs) the destruction of the parts of the chair might label the resulting pile of wood as the same particular chair having its parts destroyed, but a person who does not witness the modification of the chair may assess the pile of wood as being nothing more.

Furthermore, we can disperse the pieces of wood, in which case if we adhere to the idea that the pile is numerically identical to the chair that had become broken, then we are also committed to the idea that there is one chair being dispersed. Lowe, however, does not discuss the role that spatial regions have in establishing the identity of an object. Without an argument indicating that for the numerical identity to be maintained the pieces of wood must maintain some structural configuration that is confined to a common spatial region, Lowe's account allows for the possibility of a particular chair to occupy multiple non-immediately connected spatial regions.

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<sup>13</sup> The neo-Aristotelian will need to take into consideration commonsense observations of change given the fifth identifiable feature of neo-Aristotelianism listed above, which advocates for the use of common sense in formulating an account of substance.

<sup>14</sup> Someone might object that chairs are mere artifacts, and, therefore, not the right sort of entity for metaphysical inquiry. Lowe (2006), however, allows artifacts as a type of substance that instantiate *artificial* kinds.

<sup>15</sup> This is clearer if we treat the chair as being mereologically simple in which its division results in a destruction of the chair.

Similarly, an adequate account of change should allow for an object to undergo such extensive change that it ceases to be the same object. By committing to the idea that parts can cease to exist without modifying the quantity of stuff, Lowe allows for there to be borderline cases of objects. In particular, it is vague as to when we have an object and not some arrangement of stuff. The wooden material that comprises the chair could become incinerated, thus resulting in there no longer being any distinct parts. Without distinct parts, there are no parts that could be arranged chair-wise. Yet if the material that was once arranged chair-wise is reduced to ash and added to water, on Lowe's account, we should identify the resulting solution as being numerically identical to the chair. This, however, is a very different commonsense conception of being a *chair* since we would not upon observing some quantity of a solution believe that we are also observing a chair; instead, we would be inclined to believe that no chair exists.<sup>16</sup> But there is no clear point at which the chair ceases to exist since only its parts have been modified. It appears, then, that Lowe's account cannot accommodate what we should expect from an adequate account of change.

Lowe's account of substance appears to be unsatisfactory since it cannot accommodate our intuitions about when medium-sized objects become broken, are no longer occupying immediately connected spatial regions, or undergo extensive degrees of change.<sup>17</sup> These issues specifically highlight the extent to which objects are dependent upon some situations (or states of affairs) for determining their identity. Furthermore, what an object is will depend upon its history for us to recognize that something is in fact an instance of a kind, since each object is necessarily

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<sup>16</sup> If we did allow the possibility that we are justified in believing that we are observing a chair, then we would also allow strange statements such as 'there's a chair in a cup', 'a chair is liquid mixture', and 'I have 3 oz. of a chair' to be true.

<sup>17</sup> Although I do not find a difficulty in having our metaphysical accounts of medium-sized objects be at odds with our intuitions about those objects, the neo-Aristotelian is committed to our theories being at least consistent with those intuitions.



an instance of a substantial universal (Lowe 2012, 242). Taking into account the history of an object involves considering (temporally) relational aspects of an object; the ash solution is numerically identical to a chair because the solution is a resulting mixture of parts that *were* arranged chair-wise. But substances are meant to be ontologically independent (i.e., non-relational). To define the substance in terms of what it *was* is to no longer admit such independence.

There are many ways to define what a chair is, though, and I do not intend to offer a defense of any account of medium-sized objects,<sup>18</sup> but, on at least one account, an object is defined in terms of its function.<sup>19</sup> On this account, a chair is a chair insofar as it is capable of serving some function—holding bodies. In adopting the commonsense observation that the chair is no longer able to serve the function of holding a body when it breaks, the functionalist would surmise that the chair no longer exists when broken. This assessment, however, still results in borderline cases of the object. It is unclear at which point the chair is no longer a chair since it is possible that, depending upon how the chair breaks, it might still be capable of holding a body despite some part of it having been destroyed (e.g., in cases when only the back of the chair breaks or when it breaks in a way that still allows someone to sit upon some part(s) of the chair).<sup>20</sup>

The possibility of there being borderline cases of an object poses problems for Lowe's account of substance, since substances are instances of substantial universals (kinds). The instantiation of a substantial universal should provide clear cases of what is being instantiated. In

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<sup>18</sup> See Thomasson (2010).

<sup>19</sup> This is in line with teleological accounts such as those offered in Aristotle's *Physica* (Book II, Chapter 3).

<sup>20</sup> I am not endorsing the functionalist account of objects, only using it as an example of how we might understand objects. There is the lingering difficulty for the functionalist in offering an account of a thing's existence if what is taken to be the thing does not succeed in performing its function.

the above cases, it is unclear if a chair, stool, or ashy solution is being instantiated. Yet even in non-abnormal cases that do not involve the incinerating and mixing of chair parts, it is unclear which universal is being instantiated on Lowe's account. In the case of the chair, it is possible that both the universals for the kinds CHAIR and FURNITURE are simultaneously instantiated.

It is important to note that Lowe endorses an Aristotelian conception of universals, which has universals existing insofar as they are instantiated (Lowe 2006, 158). If his account made use of a Platonic conception of universals, then Lowe would also have to give an account of the universal, the particular, and their relationship such that something that is spatially and temporally bound (the chair) can be an instantiation of something that is not spatially and temporally bound (the universal CHAIR)—a challenge arising from *Bradley's Regress* (Bradley 1930). The adoption of Aristotelian universals, or *categories*, does not lead Lowe to argue that universals literally exist at their instances (Lowe 2006, 158). But it does require Lowe to give an account of which category the object is a member. But the ambiguity remains with respect to which category a seemingly ordinary object belongs. Although Lowe does allow the possibility for an object to instantiate multiple universals at once, this only further obfuscates the ability to determine the existence conditions for a category. This is something the neo-Aristotelian should be able to do, though, since the categories and their respective members' identity and existence conditions are allegedly distinguishable *a priori*.

Lowe, however, does not rule out the possibility for a process or some change to occur insofar as an object's properties are modified. His suggestion is in line with the ordinary conception of change as involving an entity's having one set of properties *P* at one time and a non-identical set of properties *P'* at a different time. If an object is not a complex of properties, though, as Lowe is wont to reject in light of his considerations of trope-theory (Lowe 2006, 26),

then we are not discussing *genuine* change of an object. Even though  $e$  is said to change since  $P \neq P'$ ,  $e$  at  $t_1$  is taken to be the same  $e$  at  $t_{1+n}$ . Since  $e$  is the same  $e$  at the times at which it is expressing different properties, Lowe's account thus far only explains how an object is capable of expressing different modes and exemplifying different properties at different times, but not how objects change.<sup>21</sup>

A supporter of Lowe's account might appeal to the distinction between *substantial change*, "involving either the *ceasing-to-be* or the *coming-to-be* of an individual substance," and *phase change*, "in which an individual substance undergoes certain qualitative changes...while continuing to exist as an instance of a given substantial kind" (Lowe 1998, 174-5; emphasis in original). The above discussion has only highlighted Lowe's account of phase change, whereas the request for an account of "genuine" change might be accounted for by substantial change, in which  $e$  undergoes change insofar as there are two times  $t_1$  and  $t_2$ , such that  $e$  exists at either  $t_1$  or  $t_2$ , but not both. It is unclear, though, why this should count as an account of substantial change when something ceases to exist. Many of us have the intuition that something  $x$  at  $t_1$  undergoes change at  $t_2$  while satisfying some conditions of identity at those two times.<sup>22</sup> In other words, many of us maintain that  $x$  still exists despite it having undergone change. To respond to this counterintuitiveness, Lowe emphasizes that it is not so much that  $x$  ceases to exist when  $x$  undergoes substantial change, but that  $x$  undergoes substantial change when  $x$  no longer instantiates the same kind (Lowe 1998, 174). Specifically,  $e$  undergoes change when it ceases to instantiate kind  $E$  at  $t_1$  and begins to instantiate a different kind  $E'$  at  $t_2$ .

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<sup>21</sup> There is the additional difficulty of providing an account of what is meant by 'same' and how something can be the same thing without being identical to its previous manifestation.

<sup>22</sup> I am making a more general claim about change than our thinking about entities undergoing change.

Common sense, however, does not offer a sufficient explanation for this response. Lowe's four-category ontology characterizes individual substances as both instantiating substantial universals (kinds) *and* exemplifying non-substantial universals (properties). Furthermore, kinds are characterized by the very properties that an individual substance exemplifies (Lowe 2006, 111). In saying that change occurs when an entity no longer instantiates the same kind, is to also say that the thing no longer exemplifies the same properties that characterize that kind. These properties that characterize the kind, are also what are essential to the substance such that it is an instance of that kind. To no longer instantiate some kind is to no longer exemplify the essential properties to be that particular substance. To no longer exemplify those essential properties is to no longer exist as that thing. It is no longer clear, then, in which sense the  $x$  that undergoes change is still  $x$ . Instead, it is more reasonable to maintain that  $x$  ceases to exist when it undergoes change. But this result of having something continuing to exist when it ceases to exist is the unintuitive result that Lowe's account is supposed to overcome when he argues that "an individual substance [ceases] to instantiate one substantial kind and yet [continues] to exist, as an instance of a different substantial kind" (Lowe 2006, 111).

These difficulties pose additional obstacles for our commonsense understanding of how something is able to maintain identity over time. In particular, contra Shoemaker (1969), Lowe maintains that time requires change. Since time is always occurring, change in some sense is also always occurring. Without an account of how something is able to continue to exist when it becomes an instance of another kind, we are left understanding change as involving the creation and annihilation of an entity. Yet if something is always changing, because time is always occurring, it is unclear which conditions of identity an entity is maintaining over time. This result further highlights how Lowe's account lacks support from our commonsense understanding of

change; we do not usually think of change as involving regular intervals of creation and destruction. It would seem, then, that Lowe's account can only accommodate our commonsense understanding of change by referring to the (non-essential) properties that an entity exemplifies, but doing so is to no longer offer an account of genuine change.

The problem of change poses difficulties for Lowe's account of substance since his account only accommodates the change in property expression and category membership, but his account does not accommodate our intuition that objects undergo genuine change while persisting in some sense that allows us to say that an object has undergone change. This outcome is not surprising, though, since the "puzzle of change" is a recognizable problem for substance metaphysics. Both perdurantists and endurantists have attempted to salvage the idea that something can remain the same despite our observations that the thing has undergone change. There does not appear to be any resolution near in sight, though, for the debate between perdurantists and endurantists.<sup>23</sup> Even if we reject the possibility of change, suggesting that change is only an illusion, there is still the task of explaining why change is something that *appears* to occur.<sup>24</sup> To provide an explanation along these lines would indicate that common sense poses difficulties for the neo-Aristotelian's commitment to using commonsense observations as a guide to constructing our metaphysical theories.

### 2.3.1 Summary

The above discussion provides some incentive for questioning the viability of neo-Aristotelian substance metaphysics since it has yet to provide an adequate account of change. To summarize, change is a (seemingly) regularly observed phenomenon. While neo-Aristotelians

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<sup>23</sup> Hinchliff (1996) indicates that the resolution to this debate will be dependent upon our identifying the correct account of time. He argues that this will be presentism.

<sup>24</sup> I believe this is a vacuous endeavor since to provide an argument is to attempt to *change* someone's beliefs.

aim to frame their metaphysics in commonsense terms, the neo-Aristotelian account of substance lacks support from common sense since it treats substances as being ontologically fundamental and independent; we do not observe anything as being fundamental or independent since everything we observe, including ourselves, exists in relation to something else. These relations are what allow for observations to occur. Furthermore, to identify that change in an object has occurred requires taking into account temporal relations and relations between properties and the substances that exemplify them, which is to ignore the non-relational feature of objects. As expressed, this might lead the neo-Aristotelian to reject the notion of change altogether. This, however, would require no longer strictly adhering to the adoption of common sense as the primary methodological tool for developing metaphysical accounts.

#### **2.4 Substance: Independent, Fundamental, and Non-Relational?**

What appears to generate difficulties for the neo-Aristotelian conception of substance in light of our commonsense understanding of change is not our everyday observations, but the metaphysical assumption that there is some ontologically independent substance. Since change is something that the metaphysician should explain, or at least account for why it appears as though there is change, and, as I argue in the previous section, the concept of change is something for which the substance metaphysician has yet to provide a plausible account, we have reasons to question the very basis of substance metaphysics. For this reason, this section will focus on the key, interrelated aspects of substance, being that substances are taken to be ontologically fundamental, independent, and non-relational by further questioning the intuition that there is anything that can be taken to be fundamental.

Either an entity is fundamental or it is not fundamental. To suggest that there is a fundamental entity is to imply that there is some fundamental level at which that entity exists.

Whereas we have already discussed the problem of asserting the existence of there being fundamental levels to reality,<sup>25</sup> the present concern is with there being some fundamental category. According to Lowe, a category is fundamental insofar as “the existence and identity conditions of entities belonging to that category cannot be exhaustively specified in terms of ontological dependency relations between those entities and entities belonging to other categories” (Lowe 2006, 8). This is to assume, though, that the categories are distinct and distinguishable from one another. We have already seen that this is problematic in the case of an ordinary object like a chair, where it is unclear if the chair is a member of the category FURNITURE or the category CHAIR. But this begs the question of whether there are two distinct categories FURNITURE and CHAIR, or only one genuine / real category FURNITURE of which anything that is a chair is an instance. If we consider how anything that is a piece of furniture is something that is an instance of SUBSTANCE, we then have reason to believe that SUBSTANCE is even more general a category than FURNITURE. It is at this point that it becomes clearer how for Lowe there are only four fundamental categories that has SUBSTANCE as being the most general. This, however, is not a resolved issue even among neo-Aristotelians since there is disagreement as to the number of ontological categories.<sup>26</sup>

It is not the discussion of the number of fundamental categories that I find problematic, though. Instead, I believe that the assumption that there is *any* number of fundamental categories to be challenging since it requires there being a fundamental level. I have already discussed some of the conceptual reasons for questioning there being a fundamental level in the context of

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<sup>25</sup> There have been some attempts to discuss reality in terms of *scales* rather than levels (McGivern 2012). I believe the shift to scales only further complicates the issue of offering a consistent metaphysical account since it permits the existence of entities at one scale and not at another. Instead, the account of scales only provides an epistemic explanation.

<sup>26</sup> This is part of the issue for neo-Aristotelians who attempt to develop an ontology. We see candidates ranging from two categories (particulars and universals) (Bird 2012; Heil 2012) to six categories (Simons 2012).

defining ‘metaphysics’ since the suggestion that there is a fundamental level requires the assumption that reality is stratified in terms of levels.

Why might we still maintain the intuition that reality is stratified in a way that allows for a fundamental level? Partly our thinking that there is some fundamental level is a result of the belief that physics gets at “deeper” facts of the world through its ability to reveal to us a world very different from the world of everyday experience. Ordinary objects that appear rigid and static are found to be comprised of atoms, which are themselves comprised of smaller elements. Each level of composition is revealed to us through investigations using higher energy levels to dissect each component. It would seem then that reality is at least stratified in a way that results in a distinction between the macro and micro realms. Furthermore, if it turns out that the macro level *can* be explained entirely in terms of the micro level, then it would indicate that at least one level is more fundamental than the other.<sup>27</sup>

Even though there may be some account for why we have the intuition that reality is stratified and that physics aims at getting at what is fundamental, there are still some reasons for dismissing this belief.<sup>28</sup> It is not obvious that physics aims to get at what is fundamental. In addition to recent arguments suggesting that physics does not require the concept of FUNDAMENTALITY (McKenzie 2014), the fundamentality thesis requires something stronger than scientific realism. Whereas scientific realism makes claims with respect to the unobservable entities described by a theory, the suggestion that science gets at what is fundamental also requires a commitment to the ideas that reality is stratified hierarchically and the way that

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<sup>27</sup> It is this line of reasoning that has led some (e.g., Kemeny and Oppenheim (1956)) to argue that all entities should be understood in terms of physics.

<sup>28</sup> Contra Huemer (2001) I do not believe that the intuition that *p* provides *prima facie* justification for the belief that *p*. Instead, I take intuitions, understood as *intellectual seemings*, to be entry points to inquiry. See Cappelen (2012) for a discussion of how philosophy may not need intuitions to count as evidence.



science “carves nature” is indicative of the joints and their hierarchical relations. These commitments are not the result of scientific inquiry, though. As I will discuss in Chapter 6, even less robust formulations of scientific realism have come under scrutiny by the pessimistic meta-induction, underdetermination, and, what French (2014) calls, *Chakravartty’s Challenge*. The pessimistic meta-induction suggests that since previous scientific theories have been mistaken in their accounts of the unobservable entities, it is likely that our currently best theories are also mistaken in their account of unobservables. In a similar spirit, we can also problematize the sciences’ abilities to get at any fundamental level, since each previous scientific account that was allegedly about what was fundamental was later found to be about some derivative level.

Furthermore, even if reality is stratified in terms of levels, there is the issue of how we can access those levels from our own epistemic situation.<sup>29</sup> The current method for investigating these different levels involves using higher levels of energy to break apart smaller elements. This method is similar to dissection, in which features of the world that we do not ordinarily experience are revealed. But when we dissect a biological subject, we do not say that we are investigating a different level of reality when we reveal the skeletal framework of the subject. Instead, we come to understand some different *aspect* of the subject.<sup>30</sup> We might be inclined to suggest that we have a deeper understanding of the subject under investigation, but this makes reference to the degrees to which we can understand something, and not the depth of reality that has been revealed. So, instead of using ‘levels’ to refer to reality, the term is better suited for the purposes of referring to the body of facts that we know at one moment and how those facts differ from what we know at some other time. The result being that we can have varying levels of understanding without making any claims requiring reality to be comprised of levels.

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<sup>29</sup> See Levine (2011).

<sup>30</sup> ‘Aspects’ may be better understood as ‘partitions’ here.

Another reason why it may be preferable to think of ‘levels’ as a useful metaphor instead of a metaphysical description, is that the claim that we are capable of accessing more fundamental levels depends upon an account of how entities at different levels are capable of interacting. If reality has levels  $L_1$  and  $L_2$  and each level has entities  $e$  of kinds  $E_1$  and  $E_2$ , respectively, then the following conditionals are generated:

$C_1$ : If  $L_1$  and  $L_2$  are distinct, then  $e_1$  cannot access (interact with)  $e_2$ .

$C_2$ : If  $e_1$  can access (interact with)  $e_2$ , then  $L_1$  and  $L_2$  are not distinct.

We come to believe that there are distinct levels, though, because of our observations of entities that we take to not exist among the entities of our own “level.” More importantly, we come to think of these levels as being distinct given our different descriptions for the behavior of the entities that exist at each level. For example, we describe entities of the micro state in terms of probabilities, and we, instead, assign deterministic values to macro states. It would appear, then, that we believe that there are at least two different levels since we are capable of making measurements of the entities that behave differently from the entities of our everyday experiences.

To make a measurement, however, is to access (interact with) some entity. So, given  $C_2$ ,  $L_1$  and  $L_2$  are not distinct, but it is because of this very interaction (in the form of a measurement) that leads us to believe that  $L_1$  and  $L_2$  are distinct. The resulting dilemma can be stated as follows: If  $C_1$  holds, then for any entity  $e_n$  that we interact with,  $e_n$  belongs to the same level  $L_n$  as ourselves, where ‘ $n$ ’ stands for the number assigned to the level at which we exist in the structural hierarchy. If  $C_2$  holds, then for any entity  $e_{n \vee o}$  that we interact with, it will be underdetermined whether we are interacting with an entity belonging to the same level  $L_n$  as ourselves, or some other level  $L_o$ . In the first case, we do not have reasons to posit the existence

of some other level since we can only infer that something in addition to ourselves exists at  $n$ . In the second case, in the absence of additional evidence, we are unable to uphold the view that there is some other level since we can only justifiably infer the possibility of something existing at some other level  $o$ .<sup>31</sup> The resulting issue for the substance metaphysician would be that, without additional evidence, our commonsense observations do not provide sufficient support for the view that there are distinct levels to reality.

Keeping in line with the neo-Aristotelian's implementation of common sense, one possible way to resolve this issue is to observe our everyday interactions with what we believe are distinct levels and consider if similar cases might hold for our account of reality. A commonsense instance of there being two entities belonging to two distinct levels would occur when two people Alex and Barbara stand at different steps of a staircase. Alex and Barbara are not capable of physically touching each other unless they move to a common step between the steps that they are currently standing on. But even before moving, there are other ways for them to interact; they can yell, wave, or toss objects to each other. Even though they appear to be at different structural / physical levels, there is some common level of reality that allows for these interactions. It is less clear, then, what is meant by 'distinct' in saying that levels are distinct from one another.

The stratified theory of reality might appear to be only of relevance to the eliminative materialist. Although I have provided some reasons for rejecting the idea that reality is stratified in terms of distinct levels, I have only done so by taking into account these reductionist arguments for endorsing distinct levels. Yet, reductionists, such as Oppenheim and Putnam (1958), are not the only ones who understand the world as being multilayered. For this reason, I

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<sup>31</sup> Since I am skeptical of there being distinct levels to reality, I do not know what would count as adequate evidence for their distinctness.

will briefly evaluate the distinctness of levels by considering the emergentist view that also attempts to make sense of emergent properties as arising from some more fundamental / basic level (see Kim 2008).

Arguably, a key aspect of the emergentist picture is that those emergent properties “bring into the world new causal powers of their own, and, in particular, that they have powers to influence and control the direction of the lower-level processes from which they emerge” (Kim 2008, 129). Although the idea of *downward causation* is metaphysically contentious, it has been upheld by the likes of Campbell (1974), Klee (1984), Popper and Eccles (1977), Sperry (1986), and, more recently, Bedau and Humphreys (2008). For these emergentists, downward causation plays a foundational role in our understanding of both *same-level* and *upward causation*. As Kim illustrates, downward causation is taken to be fundamental since upward causation is dependent upon same-level causation and same-level causation is dependent upon downward causation (Kim 2008, 142). But the directionality of causation is dependent upon there being levels: same-level causation requires two properties existing at the same level; upward causation requires some property belonging to some level that is below another level; and downward causation requires some property belonging to some level that is above another level. It is unclear what counts as a level for the emergentist, though. Are they to be distinguished by degrees of complexity? If so, then how is complexity measured? How is each level related to the others? The common underlying idea upheld by emergentists appears to be that emergents (those properties that have emerged) are *genuinely* emergent, and not just resultant. But to identify a property as not being resultant involves the emergent property not being predictable or explainable in terms of its basal conditions. These epistemic constraints lead some anti-

emergentists to understand an emergent property as only being a “surprise” observation resulting from not having enough information.

Setting aside the issue of whether emergent properties are either metaphysically or epistemically significant, what I find most pertinent is that emergentists are not only interested in arguing that emergents occur; the emergentist wants the emergent to also be causally efficacious. To be a cause, however, requires something to be capable of interacting. So, in the case of upward causation, as described by Kim, an entity is capable of causing some higher level entity by bringing about those basal conditions that allows for the instantiation of the emergent property. Although this provides some intuitive force behind upward causation’s reliance on same-level causation, it also illustrates how the two levels somehow need to allow for interactions for those basal conditions to give rise to / produce the emergent property. Without an interaction between levels it is unclear how one level could produce a property in another level. If we are to accept the multilayered view of reality, there are multiple levels that are capable of standing in relation to one another. Yet, because two levels stand in the appropriate relation to one another some specific property, and not others, is able to emerge; whereas if those two levels had not stood in the appropriate relation, then they would not have instantiated *that* property.

The lesson for the case of the two entities that allegedly exist at two different levels of reality, yet capable of interacting, is that there must be some place at which the levels overlap, or perhaps the boundaries between the levels are blurry. In either case, we begin to weaken the idea that levels are distinct, an idea that is necessary for any account of fundamentality (e.g., neo-Aristotelianism) to be successful. More importantly, I believe we can make better sense of these observations by positing that there is only one level of reality and that our tools afford us insight to its varying aspects which we treat as being different levels for the purposes of epistemic

bookkeeping and distinguishing fields of inquiry from one another. This suggestion provides an account of how the different entities are able to interact, but requires a shift in our intuitions regarding the sort of projects with which physicists and metaphysicians concern themselves.

The three following figures help illustrate this shift. The initial understanding of entities existing at different levels of reality can be represented as a stair (see Figure 1), with distinct levels  $L_1$ ,  $L_2$ , and  $L_3$ . For each level  $L_n$ , there exists some entity  $e_n$ .

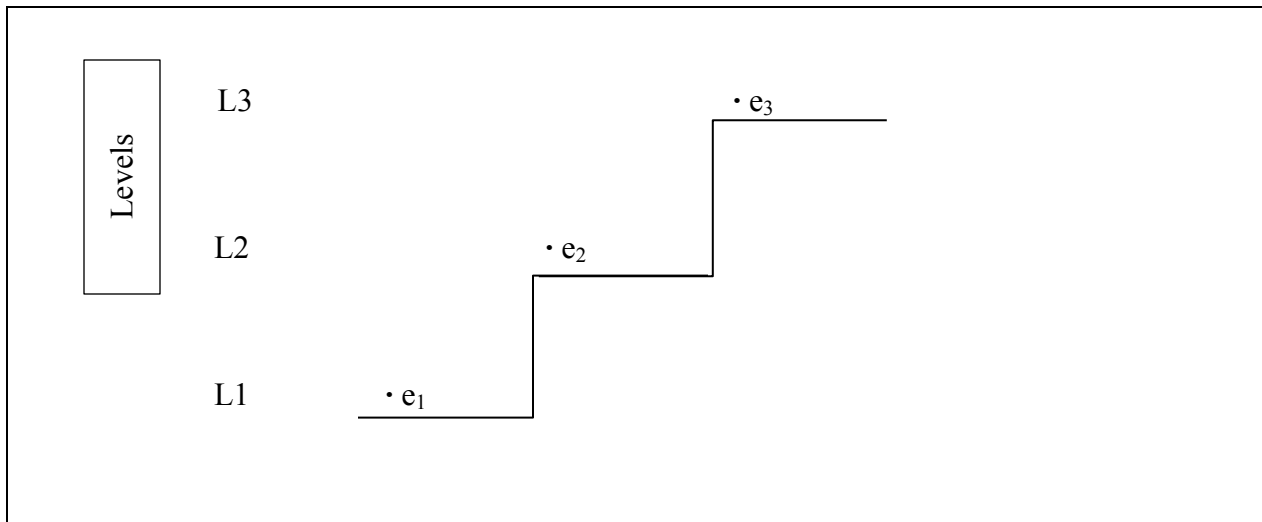


Figure 1 Contemporary view of entities existing at different levels of reality.

The challenge is to offer an account of how  $e_2$  is capable of making measurements of  $e_1$  and  $e_3$ , which are then used to make inferences about  $L_1$  and  $L_3$ , respectively. Since a measurement is itself a kind of interaction, the difficulty is to account for how  $e_2$  is capable of interacting with  $e_1$  or  $e_3$  if they exist at different levels from  $e_2$ .

One suggestion would be to have  $L_2$  be an intermediary level between  $L_1$  and  $L_3$ . In this case, although  $L_1$  and  $L_3$  are distinct from one another,  $L_2$  is common to both. Although  $e_1$  cannot exist at  $L_3$  and  $e_3$  cannot exist at  $L_1$ , the commonality of  $L_2$  allows  $e_1$  and  $e_3$  to still exist at the same level (see Figure 2).

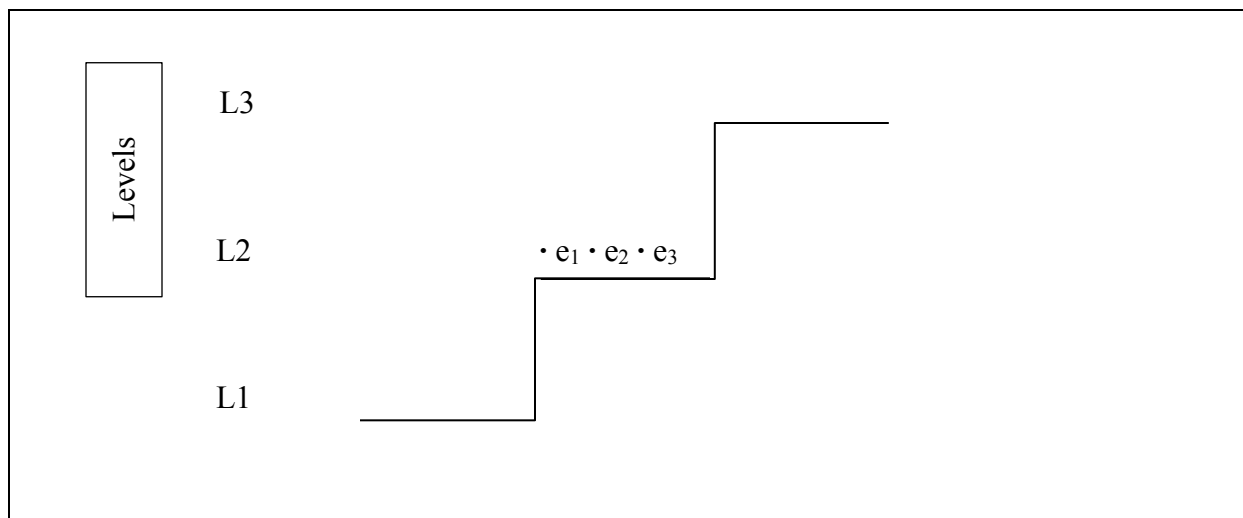


Figure 2 Entities existing at same level that provide evidence for other levels of reality.

This recommendation, however, results in two difficulties. First, if  $e_1$  and  $e_3$  are indicators of  $L_1$  and  $L_3$ , then we should be able to provide an account of how we can distinguish  $e_1$  and  $e_3$  from  $e_2$  (insofar as they are entities originating from different levels from  $e_2$ ). Yet, observations of  $e_1$  and  $e_3$  are the only available evidence for thinking that  $L_1$  and  $L_3$  exist. Although  $e_1$  and  $e_3$  may be at odds with other observed entities at  $L_2$ , the observations of  $e_1$  and  $e_3$  occur at  $L_2$ , indicating that  $e_1$  and  $e_3$  are capable of being given  $L_2$ -descriptions. For this reason, rather than positing some additional level to reality, when our only evidence for  $L_1$  and  $L_3$  are  $e_1$  and  $e_3$ , it may be best to suggest that  $L_2$  is much more complicated than we had originally thought. This suggestion has the implication that the discovery of different types of entities does not reveal to us different levels of reality; instead, we only come to know more about its various aspects. Given this possibility, it is not clear how we are able to provide an account for how we can distinguish  $e_1$  and  $e_3$  from  $e_2$  as belonging to different levels from  $e_2$ . For this reason, it appears that  $e_1$  and  $e_3$  only tell us about  $L_2$  without being indicators of there existing either  $L_1$  or  $L_3$ .

Second, if it is still maintained that  $e_1$  and  $e_3$  are indicators of  $L_1$  and  $L_3$ , then given that  $e_1$  and  $e_3$  are capable of being given  $L_2$ -descriptions, since they are observed at  $L_2$ , an account will need to be given of how they have gone from  $L_1$  and  $L_3$ , respectively. This will require an account of how  $L_1$  and  $L_3$  stand in relation to  $L_2$  such that their respective entities are capable of going to another level in a way that would allow for them to be measured or observed at that other level. The attempts to develop such an account are more problematic than the first difficulty of distinguishing  $e_1$  and  $e_3$  from  $e_2$ . Not only would such an account have to offer an account of how to distinguish  $e_1$  and  $e_3$  such that we can posit their existence, we would then also have to offer an account of how  $L_1$  and  $L_3$  stand in relation to  $L_2$  such that  $e_1$  and  $e_3$  can be measured at  $L_2$ . More specifically, we also have to offer an account of the causal relations that are instantiated between the different levels that would allow an entity at  $L_2$  to make observations about entities belonging to different levels. Given these difficulties, it appears that we should not take  $e_1$  and  $e_3$  as being indicators of other levels of reality.

Instead, if we eliminate the idea of there being three distinct levels we can accommodate how the different entities interact by illustrating how they, in fact, exist at one “level” (see Figure 3).



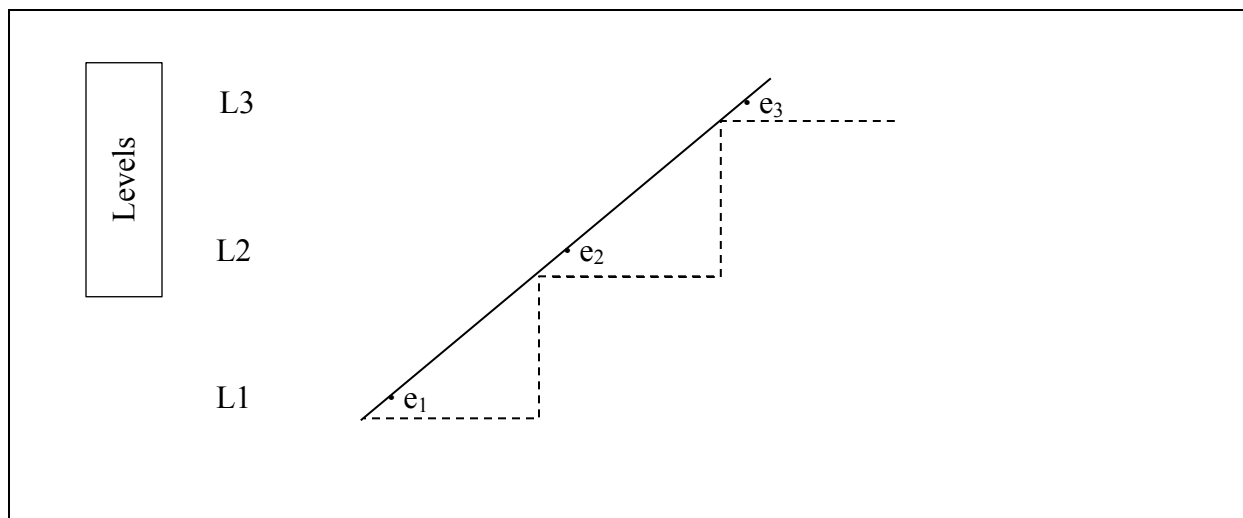


Figure 3 Proposed resolution of no longer requiring distinct levels of reality.

Although we may take  $e_1$  to be indicative of  $L_1$ ,  $e_2$  to be indicative of  $L_2$ , and  $e_3$  to be indicative of  $L_3$ , we can also think of each entity as existing at the same level, as indicated by the diagonal line in Figure 3.  $L_1$ ,  $L_2$ , and  $L_3$  could instead be thought of as different *aspects* of reality, rather than different levels. The resulting view would indicate that instead of believing that there are levels of reality, we should believe that different aspects of reality are revealed to us when using different levels of energy to investigate reality. Given the definition of metaphysics discussed in the previous chapter, as the field of inquiry concerned with aspects of reality, we can then better understand metaphysics as having as one of its projects the reconciliation of those things<sup>32</sup> that are revealed to us through the sciences.<sup>33</sup>

### 2.4.1 Summary

The implication of the above discussion is that commonsense does not provide sufficient reason for believing that substances (or anything, for that matter) are ontologically independent

<sup>32</sup> As Chapter 5 will indicate, it will be better to phrase this project in terms of the “metastable processes that are revealed to us through the sciences” instead of “things.”

<sup>33</sup> This is consistent with Ladyman and Ross (2007) who argue that unifying the sciences is one of the tasks set to the metaphysician.

since we are unable to identify a fundamental entity by only appealing to common sense.

Without being able to justify that there is a fundamental entity, we are unable to identify any set of identity or existence conditions for an entity that are not dependent upon the relations that the thing instantiates. These relations may exist among the varying “levels” of reality or the other entities upon which the thing depends for its existence. For these reasons, we are able to question the existence of there being anything that exists independently when only taking into account our commonsense observations.

## **2.5 Conclusion**

In this chapter, I have discussed in which ways Lowe’s account of substance is problematic when only appealing to our commonsense observations. To accomplish this aim, I have discussed some of the commonalities between Aristotle’s formulation of substance and those neo-Aristotelians who take themselves as providing an extension of Aristotle’s own account. Notably, Lowe’s account of substance, in the context of his four-category ontology, proves problematic when taking into account our commonsense observations of medium-sized objects undergoing, what we take to be, genuine change. These problems arise as a result of making the metaphysical assumption that substances are ontologically independent—an assumption that is itself at odds with our commonsense observations of the existence and identity conditions for medium-sized objects. The reason for only taking into account commonsense observations for this discussion is to illustrate how the neo-Aristotelian’s usage of common sense is insufficient for the purposes of developing metaphysical theories. One of the ways that the neo-Aristotelian can modify her usage of common sense is to take into account developments from the natural

sciences. Doing so would result in adopting something like methodological naturalism.<sup>34</sup> As I argue in the previous chapter, though, the preferred account of methodological naturalism is its attenuated formulation. The next chapter will evaluate the viability of neo-Aristotelian substance metaphysics by taking into account developments from physics and biology.<sup>35</sup>

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<sup>34</sup> As I will discuss in Chapter 3, this is not obviously an unwelcomed suggestion among neo-Aristotelians.

<sup>35</sup> I believe that we could also evaluate substance metaphysics by taking into account developments from chemistry.

## CHAPTER 3: THE UNNATURALNESS OF SUBSTANCE

### 3.0 Introduction

In the previous chapter, I provide an analysis of the neo-Aristotelian's account of substance by observing how using common sense as a starting point for metaphysical inquiry results in many difficulties for understanding the ontological status of substances as being fundamental, independent, and non-relational. The idea of fundamentality is especially at odds with our commonsense observations of how medium-sized objects (artifacts) undergo change. Furthermore, the lack of support for there being a fundamental level prevents us from constructing a commonsense argument for there being an entity that is fundamental, independent, and non-relational. The result is that we lose *prima facie* support for there being substances in the way that neo-Aristotelians suggest.

In this chapter, I consider whether a neo-Aristotelian is able to overcome these difficulties by taking into account developments from the natural sciences. For Lowe, entities that are taken as instances of the category SUBSTANCE can belong to two sub-categories: “*masses*, or material bodies, on the one hand, and *living organisms* on the other” (Lowe 2006, 7). Since physics provides us with insight to the composition of material bodies, while biology provides us with an account of living organisms, I will discuss quantum field theory, which Ladyman and Ross (2007) and French (2014) consider to be our best science (3.1), and then discuss contemporary developments in biology, especially the extended synthesis which is defended by philosophers of biology (e.g., Pigliucci and Müller (2010a) and Dupré 2012)) (3.2).

### 3.1 Quantum Field Theory

Although it is not claimed to be the final science, quantum field theory (QFT) has received substantial attention from philosophers of science.<sup>36</sup> This attention is due to QFT being successful with the electromagnetic, strong nuclear, and weak nuclear interactions, even though it is unable to accommodate gravity (Auyang 1995, 45). Despite its experimental success, there is still debate surrounding the appropriate interpretation of QFT and each of the various interpretations has significant implications for our understanding of ontology and metaphysics.

Instead of attempting to defend one interpretation against others, I will consider how the interactivist interpretation of QFT is problematic for the substance metaphysician's claim that individual substances are ontologically independent. In doing so, I will consider how both interpretations of the field and particle (or *quantum*) can be given interactivist interpretations. Whereas the previous chapter directly questions the issue of fundamentality by evaluating our commonsense observations of artifacts, the consideration of QFT prompts a less direct route to suspending judgment to the idea of fundamentality. The benefit being that we are able to also generate reasons for suspending judgment to other interrelated key neo-Aristotelian concepts such as *independence* and *non-relationalism*.

At various times, since the 19<sup>th</sup> Century, classical mechanics has appealed to either fields or particles to account for material bodies. Given the advent of QFT, it is not clear if they are the sort of things that would allow material bodies to be independent. It is this very independence, though, that allows material bodies to be considered as substances: “a *substance* might be defined to be an *object* which does not *depend* for its existence upon any other *object* (where dependency is defined in terms of *necessity*)” (Lowe 1998, 10; emphasis in original). In

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<sup>36</sup> I am here following Kuhlmann et al. (2002), French (2014), Ladyman and Ross (2007), and Auyung (1995).

particular, QFT's allowance for interpretations of particles and fields as being mutually dependent prompts concerns for their independence—thus, bringing into question the status of material bodies as being independent in the way that would allow for them to be substances. In understanding how QFT is derived, we can then better understand how particles and fields are interdependent.

The various classical accounts that take either particles or fields as being fundamental offer different routes for deriving QFT from classical mechanics (Kuhlmann et al. 2002, 9). On one route we quantize the variables of classical mechanics to derive quantum mechanics. Then, by quantizing those variables, we are able to derive a particle interpretation of QFT.<sup>37</sup> The quantization of the variables of classical mechanics can also result in classical field theory. A second quantization of classical field theory allows us to then produce a field interpretation of QFT.

The quantizing of the variables leads us away from using real numbers to represent values of physical quantities. Instead, physical quantities are represented by operators. As Teller suggests, “one first quantizes a classical theory by substituting operators satisfying commutation relations for numerically valued functions representing physical quantities” (Teller 1997, 62). He goes on to suggest that the shift away from having a distinct value assigned to each physical quantity prompts a move away from the classical understanding of a particle as something that is distinct and discrete. On the classical view, particles can be labeled, counted, and switched. They are understood as being the bearers of properties, much in the same way that Lowe treats objects. Notably, particles appear to be prime candidates for *haecceities*—things that exhibit primitive

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<sup>37</sup> See Dirac (1927).

*thisness*—since they are thought to be capable of being labeled and counted. But the shift away from classical mechanics also requires a reconceptualization of its entities.

Instead of particles being understood as capable of exhibiting primitive *thisness*, they are understood in terms of *quanta*. One of the principle ways that quanta differ from the classical conception of particles is that quanta can be aggregated. Whereas particles can be collected and ordered in a way that allows us to determine the position of each particle, quanta can only be collected; although gathered in discrete units, it is impossible to determine the position of each individual quantum. This inability to determine the position of each quantum is indicative of the usage of probabilities and eigenvalues to describe values of quanta instead of real numbers. Furthermore, although quanta are not to be thought of as being identical to waves, they share with waves the similarity of being collected without determining which wave is which (e.g., in the case of interference patterns). This similarity with waves further distinguishes quanta from particles in that quanta cannot be assigned exact trajectories and labels, which are needed for quanta to exhibit primitive *thisness*. This shift from a theory that makes use of distinct particles that are indexed to discrete space-time points to quanta is in line with field theory's usage of a "continuum of space-time points" (Teller 1997, 53).

Although the adoption of quanta instead of particles is a close analogue in the shift from classical mechanics to QFT, we lose the main attributes that particles are taken to possess within the classical framework. Since we lose the primitive *thisness* of particles and the ability to assign them exact trajectories, we need to better understand how it is that quanta exist. On most interpretations, quanta exist within the context of a field. On some of these interpretations quanta *just are* excitations within a field.<sup>38</sup> Such interpretations indicate that quanta are to be understood

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<sup>38</sup> See Hudson (2005).

in terms of the relations they exhibit within their respective fields. The identification of this relation indicates that they are dependent upon their fields.

The substance metaphysician, here, might look at how quanta stand in relation to fields and then infer that physics indicates that there is still some fundamental substance, but that it is the field instead of the particle that satisfies the category SUBSTANCE.<sup>39</sup> But, as Teller ardently argues, fields and particles (quanta) are interdependent since he maintains that there are no fields without quanta and no quanta without fields (Teller 1997, 9). This is perhaps one of the less intuitive aspects of QFT. Whereas it is understandable that particles (quanta) are reducible to fields, it is not clear how fields are dependent upon their respective quanta. The resistance to thinking that quanta are reduced to fields is a result of adopting a strong reductionist attitude towards physics. As I have already discussed, though, the inability of physics to explain all phenomena provides incentive for not endorsing this attitude.

Initially fields (e.g., the electromagnetic field) might be thought to be free-standing. This is at least in line with the conception of *free quantum field theory* in which quanta are understood to exist without interacting. But this is a purely theoretical stipulation for the purposes of understanding some isolated behaviors of quanta. Instead, quanta can be understood as always interacting, including with themselves. This *interactivist* picture provides some insight to understanding how a complete description of both classical and quantum mechanics will include “the interaction between an electron and the field to which that electron itself gave rise” (Teller 1997, 115).<sup>40</sup> By better understanding how the electron contributes to the formation of the electromagnetic field itself, we begin to see how electrons (or quanta) should not be thought

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<sup>39</sup> As Lowe mentions, “I am sympathetic to the view that what the relevant empirical evidence shows is that it is wrong to think of electrons and the like as really being *objects* at all” (Lowe 1998, 12).

<sup>40</sup> The interactivist view is further developed by Bickhard (2011).



simply as being reduced to a field. More importantly, we can better understand that fields are not to be thought of as free standing entities. But how are quanta capable of contributing to the development of a field?

Quanta are not understood in isolation, but more importantly, since a quantum lacks primitive thisness, it is not itself a free-standing entity, but is engaged in self-interacting processes. These interactions produce operator values, which are illustrated by Feynman diagrams.<sup>41</sup> On the traditional interpretation of Feynman diagrams, when a photon hits a fermion (either an electron, proton, or neutron), given the state of the system, a fermion is either destroyed or created. These instances of destruction and creation are described by *annihilation* or *creation* operators. In a system in which an electron is observed as going out of existence and then coming into existence, there is a “virtual” electron that is thought to exist between the moment of destruction and the moment of creation (since conservation laws of energy prevent something coming from nothing).<sup>42</sup>

One way to resolve the issue without positing the existence of a virtual electron is to consider what led to the positing of the virtual electron in the first place: the literal interpretation of equations that make use of annihilation and creation operators. These specific operators are used to describe the interaction of photons and fermions, which serve as the basis for measurement since a measurement is made only when a photon hits a fermion. Among the many problems with measurement is the difficulty of simultaneously detecting the motion and location of an electron.<sup>43</sup> Without knowing the exact motion and location of the electron, we should not

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<sup>41</sup> See Falkenburg (2007, 238).

<sup>42</sup> The status of virtual electron, however, is of much contention. See Bunge (1970) and Fox (2008).

<sup>43</sup> This is usually understood as Heisenberg’s *uncertainty principle*, but there is debate as to whether this formulation is appropriately attributed to Heisenberg since Heisenberg’s 1927 paper only deals with uncertainty relations (or *Unschärferelation*) (Hilgevoord and Uffink 2014).

be too quick in thinking that a fermion is either destroyed or created when our measurements indicate this being the case.

An alternative perspective is to think of each measurement as a “snapshot” of the interactions that occur within the system at some moment. Doing so would allow us to move away from thinking that fermions come into and out of existence. This interpretation, however, brings into question the idea that each quantum is a discrete thing that is reducible to a field. Instead, it is something interacting with its respective field. By allowing the possibility of a quantum as being an operator within a field, its behavior also impacts the very field within which it is situated. On this view, a field is affected by the self-interaction of a quantum. Such an account is consistent with Feynman diagrams that model the behavior of fields and their respective quantum, which allows us to better understand how fields are dependent upon their quantum. This interactionist picture results in the problematizing of the idea that either fields or particles independently serve as the fundamental constituents of material bodies. By understanding how the components that make up bodies are themselves not independent, we then lose support for the idea that material bodies are themselves independent; therefore, weakening the idea that material bodies are substances.<sup>44</sup>

### 3.1.1 Summary

A lingering issue with the above discussion is that it centers on an interactionist interpretation of quantum field theory instead of a trope interpretation.<sup>45</sup> A trope interpretation treats quanta as bundles of properties instead of interactions. The trope interpretation, however, is also at odds with Lowe’s account of substance since substances are the bearers of properties—

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<sup>44</sup> Even though someone might argue that QFT is about what *is* fundamental, the interactionist interpretation of QFT questions the very idea of there being some thing or substance that exists fundamentally.

<sup>45</sup> See Kuhlmann et al. (2002) for discussion of ontological interpretations of QFT.

not properties themselves.<sup>46</sup> Given the notorious difficulty of interpreting QFT it is possible that there is some interpretation that will be consistent with the neo-Aristotelian's account of substance. The metaphysician, however, is not an authority on the topic of making developments in QFT. Yet, keeping in line with methodological naturalism, the metaphysician still needs to attempt to reconcile these developments with her theories.

Even without taking into account interpretations of QFT, the bases of QFT that involve a shift away from classical mechanics are difficult to reconcile with Lowe's statement that material bodies are instances of substances. First, quantum mechanics' implementation of wave-particle duality moves away from the classical sense of a particle as exhibiting primitive thisness in the way discussed above. Second, field theory indicates that particles in some ontologically robust sense depend upon their fields in a way that prevents them from being substances. For these reasons, even without full-consideration of the details of QFT, the neo-Aristotelian account of material bodies being instances of SUBSTANCE is difficult to reconcile with contemporary physics.

The neo-Aristotelian, however, might not be too impressed with this argument since it takes into account unobservable elements that are at odds with our commonsense observations. For this reason, it may be beneficial to also take into account developments in biology dealing with some objects (e.g., organisms) that we come to believe as a result of commonsense investigations.

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<sup>46</sup> See Lowe (2006).

### 3.2 Extended Synthesis

The two categories of SUBSTANCE, MASSES and LIVING ORGANISMS, do not have the same conditions for existence or identity since “a living organism...can survive a change of its constituent matter in a way that a mere mass of matter cannot” (Lowe 2006, 7). Lowe goes on to explain that this difference between masses and living organisms prevents us from solely identifying a living organism with its matter, since “it is constituted by different masses at different stages” (Lowe 2006, 7). Although there are some similarities between our analyses of neo-Aristotelian accounts of different types of substances, their differences warrant separate considerations. In the previous section, I examined the possibility of matter being an instance of substance given current developments in physics. The current section will focus on the reconciliation of developments in contemporary biology and Lowe’s treatment of living organisms as candidate instances of substances.

Analogous to the case of recognizing how the particle in quantum mechanics is no longer to be understood as a fundamental entity capable of existing independently, organisms also require reconceptualization. Both Aristotle (see *Categories* and *Generation of Animals*) and neo-Aristotelians have given the topic of organisms serious consideration. Lowe, in particular, has attempted to make sense of how organisms can undergo change while maintaining species and genus memberships despite having undergone such change. He writes, “What makes living organisms different, in respect of their existence and identity conditions, from certain other categories of individual substance, is that they may survive a systematic change of their constituent matter, provided that they continue to exemplify a specific form appropriate to their natural kind” (Lowe 2006, 20). This characterization, however, confuses the issue. Natural kinds are substantial universals that are defined in terms of the essential characteristics that their

instantiations exemplify. For this reason, the very instantiations of natural kinds determine what is “appropriate to their natural kind.”

Similar to the case of the chair that becomes broken, there is the issue of determining how much change an organism can undergo while still enjoying category membership. I will, however, table this discussion since the ways in which living organisms undergo change results in similar difficulties of vagueness that I address in the previous chapter. The discussion of change, however, poses a more significant difficulty for understanding substantial universals since we come to understand natural kinds through their instantiations. When making observations of an individual living organism we come to realize that they heavily depend upon their surrounding environments. By observing these dependencies, we make room for questioning the idea that living organisms can be understood as being fundamental, independent, and nonrelational entities—thereby questioning their status as substances.

The underlying assumption of this section is that things do not exist by themselves; anything that exists in the actual world is always existing in some circumstance. This assumption is further established by cases of observation in which any instance of an observation requires a relation between an observer and the observed phenomenon. For example, we do not observe living organisms (including ourselves) as existing outside a situation. These observations motivate intuitive reasons for maintaining that an organism’s existence depends upon its environment. But, keeping in line with attenuated methodological naturalism, we should not adopt an idea that is developed *a priori* and at odds with naturalistic developments (although we may have reasons to further pursue the idea). To ensure that the claim that an organism’s existence depends upon the environment is not at odds with naturalistic developments we will also need to evaluate its viability in the context of developments from biology.

There is much contention in biology regarding the appropriate “unit of selection.” In particular, it is unclear if natural selection selects for individual organisms, entire species, or ecosystems. Furthermore, identifying individual organisms is further complicated when medium-sized organisms, such as ourselves, are mostly comprised of micro-cellular organisms. Without a clear account of what natural selection selects and how to individuate organisms, it is difficult to provide adequate accounts of how adaptation occurs and what is adapting.

Proponents of the *extended synthesis* have attempted to accommodate these issues by incorporating many aspects of Darwinian evolution and the modern synthesis (Pigliucci and Müller 2010, 11). From Darwinism, we find the ideas of *variation*, *inheritance*, and *natural selection* being included. From the modern synthesis, the extended synthesis incorporates *population genetics*, *contingency*, and *gene mutation*. Both Darwinism and the modern synthesis, however, do not take into account *epigenetic inheritance* and *multilevel selection*. The development of these traits, among others, distinguishes the extended synthesis from its predecessors. In large part, the most novel idea found in the extended synthesis is the feedback system formed by *niche construction* and natural selection, which allows organisms to evolve and develop in conjunction with their environments.

Contemporary theoretical shifts in biology produce similar results to those brought about by shifts in physics. By taking into account how organisms and their respective environments are capable of contributing to each other’s development, we lose support for the idea that they are distinct from one another insofar as they are instances of distinct kinds. For example, by observing an individual organism, such as an individual zebra, we come to believe that the organism is a zebra because it is an instance of the kind ZEBRA. By maintaining membership to the kind ZEBRA, the individual organism is taken to express essential attributes that are taken to

be characteristics of the members of that kind. Yet, when we are observing an individual organism, we ignore many aspects of the organism—namely, the environmental conditions that allow for the organism to exist as such (i.e., those environmental conditions that are necessary existence conditions). A way to identify these conditions is to consider how changes in the environment result in changes in the organism itself. Similarly, the change of fauna in an environmental setting significantly modifies that area. For example, although there are attempts to reintroduce grey wolves to Yellowstone, their initial decline has resulted in a radical shift in the number of deer, which has directly led to changes in the local landscape (Morell 2007).

There are many examples of animals and environments modifying each other's abilities to remain stable and develop, indicating that these relationships are mutually dependent. More importantly, though, the idea of an individual organism requires considerations of the general circumstances in which the individual organism exists. This shift in our understanding is analogous to those shifts in QFT, in which we no longer understand particles and fields existing independently of one another.<sup>47</sup> Whereas the developments in QFT call into question the existence of a fundamental object of the kind that substances are taken to be, these developments in biology allow us to further call into question the existence of natural kinds (of which substances are taken to be instances).

Natural kinds are for Lowe one of the four fundamental categories (Lowe 2006, 158-9). Specifically, natural kinds are substantial universals of which substances are instances. From our commonsense observations of substances, in this case living organisms, we can then make claims about their respective natural kinds. For example, although false, the statement 'all swans are white' was thought to be true given the observation of each individual swan involving the

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<sup>47</sup> As I will discuss in Chapter 6, a lingering issue is whether or not *relata* are necessary for these sort of relations.

observation of it being white. The property *whiteness* was then thought to be an essential property of being a swan so that it was then taken to be a characteristic of the kind SWAN.

Some neo-Aristotelians have extended this approach of using common sense by also incorporating theoretical developments. For example, Rosenkrantz explains that being a natural kind involves *a posteriori* theoretical discoveries of natural science and them figuring into natural laws (Rosenkrantz 2012, 90n.9). The case of thinking that white is a characteristic of the kind SWAN, allows the law-like statement ‘all swans are white’ to contribute to both explanations (on the *D-N* model of explanation) and to assist in generating predictions regarding future swans. As Koslicki indicates, the ability for a kind to be part of law statements is consistent with Aristotle’s own account of the sort of projects that science should adopt: “science [for Aristotle] is concerned only with lawful connections among kinds of phenomena (i.e., universals)” (Koslicki 2012, 198). Lowe’s account is consistent with these theoretical developments that result in making law-like claims since he maintains that an object (either matter or living organism) “*necessarily* instantiates its kind” (Lowe 2012, 242; emphasis my own). Even though theoretical discoveries can aid in our understanding of kinds and how they figure into law statements, the neo-Aristotelian uses common sense as the starting point for identifying such kinds (see Chapter 2).

It is difficult, though, to understand the appropriate account of kinds when starting from common sense. Whereas the adoption of common sense by the neo-Aristotelian in identifying organisms results in identifying distinct natural kinds that allow taxa to be distinct from their environment, common sense also allows us to see organisms as defined in terms of their relations with the environment. Given an observation of some living organism (e.g., a particular fish), it is unclear what counts as the instance of the kind (e.g., FISH) since the living organism depends on



its environment in such a way that the removal of the organism from its environment (e.g., water) prevents the sustainment of the organism. In other words, the removal of a living organism from a particular environment causes the living organism to cease to exist. What it is to be a living organism, then, appears to include both the particular organism and its environment.

The difficulty of identifying rigid boundaries for the environment poses additional obstacles to identifying the appropriate kind that a living organism instantiates. Similar to the case in which a medium-sized object is capable of instantiating multiple universals, since some universals are subsets of others, a living organism inhabits multiple environments. Whereas an individual living fish inhabits a watery environment, the kind of watery environment (e.g., lake, stream, or ocean) plays a role in determining the kind of fish a person is able to observe. Yet, these watery environments are defined in terms of their relations to other environmental structures. If a watery environment is mostly surrounded by land, then it is possible for the fish to be existing in a *pond, lake, bay, or gulf*. So, it is not only the water conditions that determine what kind of fish we are observing, but also the relations the body of water has to the land that aids in our understanding of the kind of fish. The identification of these different environments leads us to identify each kind as being instantiated by different living organisms. A saltwater fish that inhabits a bay may be very different from deep sea fish. Furthermore, each living organism may easily be understood as instantiating multiple kinds since some kinds are subsets of other kinds. These specific issues may not be problematic for the neo-Aristotelian since some categories are taken to be more fundamental than others, but it is unclear how to identify the appropriate kinds of which we take organisms to instantiate given the difficulties in distinguishing organisms from their respective environments.

Once we begin taking into account an organism's surrounding environment for the purposes of understanding the essential characteristics of an organism, it is less clear how an organism necessarily instantiates a kind in the way that Lowe suggests. The problems of identifying essential characteristics and kinds are a result of observing that both living organisms and their surrounding environments undergo substantial changes.

These problems are elucidated by cases having the following form: A species *S1*, which is an instance of kind *K*, undergoes change (evolves) to become some other species *S2*. It is not clear, though, if *S2* is also an instance of *K* despite *S1* being the causal antecedent to *S2*'s existence.<sup>48</sup> The case is further complicated by taking into consideration the possibility of *S2* undergoing a similar change as the shift from *S1* to *S2*, thus causing *S3*'s existence. *S3*, however, is possibly an instance of a different kind *K\**.<sup>49</sup> Similar to *S1* and *S2* not necessarily both being instance of *K*, *S2* and *S3* might not both be instances of *K\**—even though *S2* is the causal antecedent to *S3*.<sup>50</sup> Three cases result from this possibility:

*Case 1:* *S1* is an instance of *K*, *S2* is an instance of *K*, and *S3* is an instance of *K\**.

*Case 2:* *S1* is an instance of *K*, *S2* is an instance of *K\**, and *S3* is an instance of *K\**.

*Case 3:* *S1* is an instance of *K*, *S2* is not an instance of *K* or *K\**, and *S3* is an instance of *K\**.

In the first case where *S1* is an instance of *K*, *S2* is an instance of *K*, and *S3* is an instance of *K\**, we can think of *S1* as being the cause of *S2* and *S2* being the cause of *S3*. Although I will not be delving into the technical aspects of various accounts of causation, there are intuitive

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<sup>48</sup> The case can be made for kinds of environments in which 'Sn' is substituted by 'En'.

<sup>49</sup> An example of this scenario would be contemporary attempts to understand the appropriate classification of *Tiktaalik roseae*, which appears to be an intermediary species between mammalian land animals and fish (Daeschler, Shubin and Jenkins 2006).

<sup>50</sup> These scenarios of instances of kinds being causes of other kinds are also applicable to environments.

aspects of causes that aid in illustrating why the first case is a problem for neo-Aristotelians. In particular, it seems that like causes produce like effects. This is a general principle that Hume developed more indepthly in both his *Treatise* and the *Enquiry Concerning Human Understanding*. In the first we find a metaphysical formulation of the relation between causes and effects that contributes to our expectations of what causal processes involve. Hume writes, “Like causes still produce like effects; in the same manner as in the mutual action of the elements and powers of nature” (Hume 1978, 401) after having stated “It should... be expected... that like causes must produce like effects, and a perfect transition arise from the double relation, as in all cases” (Hume 1978, 339). Since  $S1$  and  $S2$  are both instances of the same kind  $K$ , then it is understandable how they are capable of standing in a causal relation with one another. The difficulty, however, is attempting to understand how instances of different kinds are able to stand in a causal relation such that  $S2$  can be the cause of  $S3$ . If we maintain that like effects must have like causes, then there must be some degree of similitude between  $S2$  and  $S3$  such that they are causally related. The difficulty is providing an account of *how* similar they must be for a causal relation to be established, while having enough differences that they are capable of being instances of different kinds.

Without an account ready at hand, it would appear that we cannot have both the principle that like effects have like effects and the idea that there are distinct kinds. Yet, both of these are in line with common sense observations of the world; it does appear that the world is carved up in terms of distinct kinds and it does appear that things exhibit some degree of similitude to instantiate causal relations. Something has to give. We have regular interactions with what appear to be causal relations in the way that Hume suggests. We do not, however, have interactions with species or kinds—only living organisms that are taken to have species and kind

membership. For this reason, it would appear that if we adopt common sense as a method for assessing which of these ideas we should adopt then, it would appear that we lose support for the idea that living organisms are instances of kinds.

Even if we reject the idea that Hume put forward a metaphysical principle, the problem still stands if we shift to an epistemological formulation of the sort that we find in his *Enquiry*: “But not withstanding this ignorance of natural powers and principles, we always presume, when we see like sensible qualities, that they have like secret powers, and expect, that effects, similar to those which we have experienced, will follow from them” (Hume 1999, 21). Since the neo-Aristotelian begins with common sense, she may not be inclined to think that there are “secret powers” resulting in similar effects, but if the neo-Aristotelian is to explain causes, as many neo-Aristotelians are wont to do, then identifying causes, in the same vain as other metaphysical theories will start from common sense observations of causes. For this reason, then, a metaphysical account of causes for the neo-Aristotelian will be dependent upon the initial belief of what counts as a cause, which places the neo-Aristotelian in the dilemma that weakens the idea of species being instances of kinds if species are causal antecedents to other species.<sup>51</sup> An implication of this dilemma is that it may require a shift in our thinking of species varying only in terms of similarity relations rather than kinds if they are to contribute to the development of other species.

A similar problem arises in the second case where  $S1$  is a member of  $K$ ,  $S2$  is a member of  $K^*$ , and  $S3$  is a member of  $K^*$ . The problem in this case, rather than being located at the transition from  $S2$  to  $S3$  as in the first case, occurs at the transition from  $S1$  to  $S2$ . A further

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<sup>51</sup> Unfortunately, neo-Aristotelians only discuss Hume’s account of causation in the context of suggesting that he puts forward an account that is at odds with a dispositional account that has effects being distinct from their causes. The closest consideration is Guenin (2012).

difficulty highlighted in this second case, although it occurs in the first case, is understanding if transitivity holds for causation, where if  $S1$  is the cause of  $S2$ , and  $S2$  is the cause of  $S3$ , then  $S1$  is the cause of  $S3$ . This would allow the possibility of instances of  $K$  being causes of instances of  $K^*$ , which, as I have discussed in the first case, is problematic given the commonsense observation that like causes have like effects.

The third case, where  $S1$  is a member of  $K$ ,  $S2$  is not a member of either  $K$  or  $K^*$ , and  $S3$  is a member of  $K^*$ , is most problematic for the neo-Aristotelian account of kinds. Whereas the first two cases are generated by adopting debatable features of causal relations, this last case emphasizes what is needed for a species to count as an instance of a kind.  $S2$  may lack the essential characteristics for being a member of the kinds of which its causes and effects are instances. The difficulty, then, is determining if a member of  $S2$  is an instance of some other kind  $K^{**}$  or is not a member of any kind at all. If a member of  $S2$  is not a member of any kind at all, then some account will need to be given that distinguishes members of species that are instances of kinds and those members of species that are not instances of kinds. It is unlikely, though, that such an account can be given since it is by making observations of individual living organisms as being members of species that allows us to infer that they are instances of kinds. Furthermore, each living organism, for Lowe, necessarily instantiates a kind—this is what makes it a candidate for being a member of the category SUBSTANCE. So, the neo-Aristotelian would not allow the possibility of a living organism *not* being an instance of a kind. So, the other alternative is for a member of  $S2$  to be an instance of some other kind  $K^{**}$  distinguishable from  $K$  and  $K^*$ . This, however, indicates that kinds are dependent upon species. If this is the case, then there does not appear to be any principled reason for having an ontological category of kinds beyond species membership.

On Lowe's account, kinds are distinguishable in virtue of their essential characteristics (Lowe 2012, 243). But a case in which a species does not have any set of properties essentially is a case in which the individual organisms of a species are not also instances of a kind. These possibilities are further explored by proponents of *gradualism*, which indicates that species undergo change very slowly rather than in large spurts, as proponents of *punctuated equilibrium* would have it. More importantly, these findings indicate that species do not necessarily instantiate kinds—thus prompting concern for the commonsense account of organisms.

There are additional reasons for calling into question the commonsense conception of organisms. First, it is not clear why we should think of living organisms as instances of kinds akin to other examples of substances. Living organisms are much more complex than other natural kinds (e.g., water). Lowe is privy to this difference: “what makes living organisms different...from certain other categories of individual substances, is they may survive a systematic change of their constituent matter, provided that they continue to exemplify a specific form appropriate to their natural kind” (Lowe 2006, 20). Water does not evolve, if at all, in a way that is identifiable with living organisms. If water no longer has the chemical composition  $H_2O$ , then it is no longer *water*. For something to be water, it essentially must be comprised of hydrogen and oxygen atoms, which are themselves appropriately arranged. Yet, and this is the second point, a living organism such as a tiger has evolved. Even if we accept that organisms are instances of kinds, and kinds are to be understood as *genuses*, then we would also have to allow the possibility of *genuses* undergoing change.

These findings are in line with other criticisms that suggest that essentialism prevents the development of an adequate taxonomy (Hull 1965). These problems with developing a taxonomy are a result of having endorsed a commonsense conception of organisms, in which individual

organisms are understood as being instances of kinds distinct from their respective environments. It is this very commonsense perspective of organisms that motivates the neo-Aristotelian understanding of living organisms as being an instance of substances.

These problems further motivate the shift away from the commonsense understanding of organisms. We have already seen some ways in which this shift might occur by considering how niche construction and natural selection, as developed in the context of the extended synthesis, function in tandem to contribute to the development of living organisms and the environments in which they are situated. Proponents of developmental systems theory (DST) such as Dupré (2012), Keller (2010), and Oyama (2000) adopt these lessons to suggest that organisms are not appropriately understood in terms of distinct entities, but should be understood in terms of general life processes or cycles. Both proponents of the extended synthesis and DST incorporate the naturalistic developments that provides us with naturalistic reasons for reconceptualizing our commonsense understanding of organisms.

Furthermore, since the commonsense account of organisms is the very reason that leads Lowe to maintain that substantial universals exist, since universals on his account exist insofar as they have instances, we then have naturalistic reasons to suspend judgment to the existence of these universals. As the discussion currently stands, to overcome these difficulties the neo-Aristotelian will need to either offer an account of how kinds can undergo change or will need to allow the possibility that organisms are not necessarily instances of kinds. Endorsing the first horn of the dilemma will prove problematic for the idea that kinds are characterized by essential attributes. The second horn, however, will be even more problematic since giving up the idea that living organisms are instances of kinds entails that living organisms are no longer exemplars of substances.

### 3.2.1 Summary

The above discussion can be summarized as follows: Lowe understands substances as being divided into the categories of MASSES and LIVING ORGANISMS. Although these are both taken as categories of substances, insofar as their members are ontologically independent, fundamental, and non-relational, their members possess different identity and existence conditions. Contemporary physics (e.g., QFT), however, provides reasons for calling into question the ontological status of the alleged fundamental constituents of reality (i.e., particles and fields) as being instances of the category SUBSTANCE. Similarly, developments in biology (e.g., extended synthesis and DST) provide reasons for reconceiving the idea that living organisms are capable of being understood independent of their environments. Instead, we have reasons for thinking that organisms and their environments engage in dynamic interactions that form general processes or life cycles.

Given attenuated methodological naturalism, we should understand metaphysical claims as being defeasible in light of naturalistic claims to the contrary. The claims taken into consideration from physics and biology call into question the possibility of there being anything that is understood as being ontologically fundamental, independent, and non-relational. Since the neo-Aristotelian identifies categories with their instances, and we have methodologically naturalistic reasons for suspending judgment with respect to the instantiation of the necessary features of substances, we then have reason to suspend judgment with respect to the category SUBSTANCE. The result being that since neo-Aristotelian metaphysics is the science of essences, and essences depend upon substances, the suspending of judgment to the concept of



substance leads us to suspend judgment to the idea of there being essences.<sup>52</sup> This result provides reasons to suspend judgment to the viability of neo-Aristotelean metaphysics, and, since neo-Aristotelian metaphysics is the clearest formulation of substance metaphysics, we then have reason to suspend judgment to the truth of substance metaphysics in general.

### 3.3 Potential Objections

I am not the first to critique neo-Aristotelianism or substance metaphysics. Bickhard (2009) and Seibt (2002) offer general criticisms of substance metaphysics, Ladyman and Ross (2007) offer specific criticisms of neo-Aristotelianism, or what they call “neo-Scholastic metaphysics” (Ladyman and Ross 2007, 7-26). Their criticisms, however, are mostly polemical and are unlikely to sway those who are not already sympathetic to their position.<sup>53</sup> Although not as outspoken, I do reach a similar conclusion to their arguments and provide similar reasons. Notably, the argument I give is in line with Ladyman and Ross’ adoption of naturalism to evaluate metaphysical theories. In particular, it is an evaluation of the “received view” in metaphysics, given the adoption of attenuated methodological naturalism.

The above argument may not be worrisome to all neo-Aristotelians. Some neo-Aristotelians, such as Fine (2012), maintain that the implementation of the *a priori* is what distinguishes metaphysics in general from other fields of inquiry; however, the *a priori* is not obviously distinct from the *a posteriori* as Quine (1951) argues. Furthermore, *a priori* knowledge is dependent upon abstractions in those cases where *a priori* knowledge is understood as being acquired or justified independent of experience. This is what Tahko (2012), Lowe (2006), and Fine (2012) have in mind when they refer to “*a priori* knowledge.” In particular,

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<sup>52</sup> Tahko (2012) adopts Lowe’s characterization of metaphysics being the science of essences that I discuss in the previous chapter.

<sup>53</sup> This point will be further developed in Chapter 6.

they understand *a priori* knowledge being employed for the purposes of establishing what is metaphysically and epistemically possible. As I will discuss below, they understand *a priori* knowledge as a necessary precursor to scientific practice.

My current focus is on those neo-Aristotelians who are sympathetic to the idea that metaphysics is either already naturalized or capable of being naturalized. For example, in response to the objections Ladyman and Ross levy against neo-Aristotelians, Tahko suggests “that the call for naturalization is deeply mistaken: not only is Aristotelian metaphysics *already* naturalized, it is also a necessary precursor of all scientific activities” (Tahko 2012, 27; emphasis in original). I will first respond to Tahko’s claim that metaphysics is already naturalized before discussing the claim that metaphysics is a necessary precursor to scientific activities.

### 3.3.1 Is Metaphysics Already Naturalized?

With respect to Tahko’s first point, he believes that neo-Aristotelian metaphysics is already naturalized since he understands metaphysics and science to be “continuous” with one another. If we accept that metaphysics and science are both needed for the purposes of understanding reality, then some clarification is needed regarding the ways in which the two are “continuous” with one another so that there is no sharp boundary between the two fields. At the very least, it would seem that the two fields should inform one another—something that Ladyman and Ross believe is currently lacking. Tahko is aware of this criticism when he writes in reference to Ladyman and Ross, “Their primary criticism is that metaphysics suffers from a lack of scientific rigor and is in fact *very badly informed* of the latest developments in science” (Tahko 2012, 33; emphasis my own). Although Tahko is mistaken in his characterization of

many aspects of Ladyman and Ross' criticisms,<sup>54</sup> he correctly identifies the objection that Ladyman and Ross put forward as being centered on metaphysics' disengagement from the sciences.

Although it is not clear what Tahko means by metaphysics and science being "continuous," it is at least clear that Tahko maintains that they are continuous because "we could not get very far in our inquiry into the nature of reality with just one of these disciplines" (Tahko 2012, 33). Simply because two methods of inquiry contribute to our understanding of reality, however, does not mean that those two methods are continuous. For example, there is much debate on the status of mathematical entities (Shapiro 2000). Mathematics has a close relationship with the natural sciences. Both mathematics and science have the capacity to contribute to our understanding of reality. Whereas the natural sciences deal with naturalistic matters and their theories serve as examples of what it means for a theory to be naturalized, mathematical theories are not obviously naturalizable. Although the natural sciences heavily depend upon mathematics for their success, mathematics does not depend upon the sciences in the same way for its own success. This asymmetry of dependence indicates how the two are discontinuous, although they both contribute to our understanding of reality.

A similar asymmetry can be identified in those metaphysical issues that do not directly draw upon scientific evidence, but still contribute to the sciences' abilities to better understand reality. For example, discussions of identity do not draw upon scientific evidence for the purposes of establishing the truth of *Leibniz's Law (LL)*, which states that if two things,  $x$  and  $y$ , have the exact same properties, then  $x = y$ . Yet, the establishment of *LL* involves making claims

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<sup>54</sup> Where Tahko paraphrases Ladyman and Ross' objection "if metaphysics is not supported by current physics, then it has *no* value" (2012, 27; emphasis my own), he overlooks their allowance for those metaphysical theories that also contribute to the development of physical theories. These points are further discussed in Chapter 6 when I discuss their principle of naturalistic closure and the primacy of physics constraint (Ladyman and Ross 2007).

about reality—what it means to say that two or more things are identical. The topic of identity is of use to the physicist who concerns herself with issues of *entanglement* and *non-locality*. In particular, *LL* has served as a background assumption to illustrate how single-state nonlocality experiments establish the “equivalence of a single state and an entangled state (Dunningham and Vedral 2007). If it turns out that *LL* is false,<sup>55</sup> then the claims about non-locality would also require revision even though the establishment of *LL* itself does not require scientific evidence.

Even in cases in which they appear to mutually assist one another (e.g., discussions on time) there is still reason to question the continuity of metaphysics and science. Science (understood as a collective effort) is a more recent field of inquiry than those activities that are traditionally classified as being metaphysical. An account should then be given to explain how the two have become continuous. One attempt at developing such an account is Russell’s suggestion that advances in science resolve problems in philosophy (Russell 1919).<sup>56</sup> I am in agreement that many problems that are resolved by scientific developments are problems that have their origins in philosophy, but I disagree that science “robs philosophy” of its problems in the way that Russell suggests (Russell 1919, 379). Instead, I believe scientific developments reshape a problem or contribute to our understanding of the general issues in which a problem is situated, but this does not mean that the problem is no longer given philosophical consideration. This allows us to better understand how the various scientific fields that have either generated their own methodology or set of permissible assumptions originate from philosophical questions.

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<sup>55</sup> As Armstrong suggests is the case (Armstrong 1978, 94-97).

<sup>56</sup> He also suggests that philosophy and science are both concerned with reality.

<sup>57</sup> Some physicists (e.g., Ellis) suggest that some philosophical position needs to be assumed for the purposes of conducting science (Ellis 2014).

This interpretation would allow for the possibility of science being continuous with metaphysics since metaphysical questions may serve as the catalyst for scientific pursuits. It is not clear, though, the extent to which metaphysics is continuous with the sciences. We might think that metaphysics and science are continuous since scientific advancements offer insights to new possibilities for the metaphysician to consider.<sup>58</sup> It is also possible for metaphysics to be continuous with the sciences if metaphysical claims and scientific claims are held hostage to each other's developments. Tahko, however, in line with Bacon (1620), maintains that "philosophy is the queen of the sciences" (Tahko 2012, 32). Philosophy having this foundational role undermines the possibility of metaphysics and science being continuous. If philosophy is primary, then it is not obvious that science has any impact on how philosophy develops. This possibility further undermines the idea that metaphysics and science are continuous with one another if continuity requires the two fields making mutual contributions. The extent to which they need to inform one another, however, is unclear since Tahko himself does not clarify what it means for the two fields to be continuous.

Presuming that some account *can* be given for how metaphysics and science have become continuous despite philosophy being the sciences' queen, there does not appear any obvious reason for them to maintain their continuity. It is possible that science will no longer require the use of tools that have been "pillaged" from metaphysics in the way that French (2014) recommends. Also, many metaphysical puzzles may be further pursued without requiring the use of scientific techniques. These possibilities are accommodated by the attenuated methodological naturalism I develop since metaphysical claims are not dependent upon scientific

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<sup>58</sup> Developments in quantum mechanics have been particularly fruitful in this regard with discussions of probabilities and multiverses (Wallace 2012).

claims even though the metaphysician should still be aware of the extent to which her claims are consistent with science.

### 3.3.2 Is Metaphysics Primary?

The above discussion assesses Tahko's claim that metaphysics *is* naturalized because metaphysics and science are continuous. One of the difficulties for understanding this continuity results from Tahko's claim that philosophy is the queen of the sciences, but more specifically that

The expression 'Aristotelian metaphysics' suggests a commitment to the view that there is a study that is different and prior to natural science. Metaphysics is 'first philosophy', the core and beginning of any and all philosophical and rational inquiry into the world. The task of metaphysics is not to serve science or to clear conceptual muddles, but to study being and the fundamental structure of reality at the most general level. (Tahko 2012, 1)

Although I have already discussed why the belief that philosophy has this role weakens the belief that philosophy and science are continuous, Tahko also makes use of this relation to highlight how metaphysics may not be dismissed as being unnatural. In particular, by philosophy being the queen of the sciences, metaphysics' incorporation of *a priori* methods allows metaphysics to serve as a necessary precursor to scientific activities. This is a view that Tahko shares with Fine (2012) and Lowe (2006) in arguing that

*a priori* inquiry is needed to delimit the space of possibilities from which the actual structure of reality can be identified by empirical means. Consequently, *a priori* inquiry is necessary and prior to knowledge about actuality, because without this metaphysical delimitation of what is possible, the space of

possibilities would be too vast to handle. So, it is this *a priori* delimitation of the space of possibilities which enables us to pick out just the genuine *metaphysical* possibilities from the enormous space of conceivable yet metaphysically impossible things. (Tahko 2012, 39)

Tahko develops this stance in response to Ladyman and Ross who “are opposed to the idea that metaphysical *a priori* inquiry could reveal what is possible in advance of empirical research” (Tahko 2012, 39).

Tahko is not addressing the same issues as Ladyman and Ross, though. Whereas the point that Ladyman and Ross are making is about what allows for the possibility of *a priori* inquiry, Tahko’s point is an epistemic claim about how “*a priori* inquiry is needed before empirical data becomes intelligible” (Tahko 2012, 40). To highlight this distinction and further bolster Ladyman and Ross’ criticism, we can observe how *a priori* inquiry makes use of abstractions and how the activity of abstraction is itself dependent upon experience.

There is much disagreement on the nature of abstractions and determining the sort of entities that *abstracta* are (Campbell 1991). At the very least, the epistemic activity of abstraction involves taking into consideration some information while ignoring other possibly relevant information. This emphasis on some information, while ignoring other aspects, is endemic to *a priori* methods. For example, in the use of thought experiments (e.g., trolley cases) some factors are emphasized (e.g., the number of people on different tracks), while some factors are ignored (e.g., who the people are). Yet, as I argue in Winters (2014), it is by being immersed within and experiencing a world that we are capable of forming abstractions—thereby suggesting

that experience is a necessary precursor to engaging in those abstractions that are taken into account for the purposes of delimiting the space of possibilities.<sup>59</sup>

The way that experience is a precursor to delimiting the space of possibilities is significant for understanding how the *a priori* serves as a foundation for scientific activities. For example, scientific explanation is an activity in which the situatedness of an individual and her experiences determine the very space of possibilities that can be delimited for the purposes of forming an explanation. This is a view that has been developed in large part by Kitcher (1989) and Salmon (1984), in which an initial partitioning of the relevant explanans aid in elucidating the explanandum under consideration, where different partitionings afford different explanations. Van Fraassen (2008) has also adapted a similar, albeit more pragmatic, position in identifying how what will count as the relevant explanans will depend upon the initial interests of the persons seeking and providing the explanation. These approaches to scientific explanation are in line with Ladyman and Ross' discussion of how the *a priori* is informed by experience (Ladyman and Ross 2007, 10).

The issue with which they concern themselves is what allows the *a priori* to be possible, which is a slightly different topic from the one that Tahko concerns himself. Determining which information is relevant within a scientific context is a cognitively sophisticated task. It involves distinguishing between scientific and non-scientific data. To make these distinctions, a significant amount of theoretical machinery needs to be in place. As Tahko indicates, this is not a conceptual framework that aids in conceptual analysis. Instead, it is machinery that allows an analysis of *natures* (Tahko 2012, 41). So, whereas Tahko's account addresses how information is assessed once that theoretical framework has been developed, Ladyman and Ross concern

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<sup>59</sup> I follow Lewis (1973) in claiming that abstraction does not create new entities.



themselves with what contributes to the development of that framework. It would appear, then, that their two accounts can be reconciled given that Tahko focuses on how the framework functions, while Ladyman and Ross are concerned with its origin.

The lingering issues for Tahko's account is his more robust modal claim that because a theoretical framework is needed for the purposes of delimiting the space of possibilities, and that those metaphysical possibilities exist prior to their assessment, we can then infer that possibility precedes actuality. First, Tahko trades between metaphysical and epistemic possibility. In making observations about what is epistemically possible within a scientific context, he reaches claims about metaphysical possibility; specifically, that possibility precedes actuality. This inference is problematic, though, since the way in which information is assessed is not a direct indicator of modal relations. It is just as plausible to infer on his account that actuality precedes what is possible since we can assume that the world has an actual inherent structure. This structure itself limits the range of ways that we can come to understand that structure. The claim that what is metaphysically actual preceding what is metaphysically possible does not violate his endorsement of the claim that what is epistemically possible precedes what is epistemically actual, though.

The main difficulty with his account is that in identifying what is metaphysically possible we are then able to identify what is the case. But this difficulty is generated by his thinking that "metaphysics deals with possibilities" (Tahko 2012, 39). Although this may be one of the issues with which the metaphysician concerns herself, she is also interested in what is actual. Tahko is aware of this interest since, as he remarks in the quote above, that the metaphysician is interested in the "fundamental structure" of reality. This is not a concern with what the possible structure might be, but with the actual structure. It would seem, then, that the metaphysical concern with

the actual structure of reality would be something that precludes our possibility for knowing the various ways that the world could be like. For this reason, it would seem that Tahko himself could endorse the view that what is actual precludes what is possible.

The second issue is this. Even if we consider only epistemic issues, it is a mistake to infer that possibility precedes actuality. There are cases in which possibility precedes actuality and there are other cases in which actuality precedes possibility. Tahko's discussion highlights the ways in which our *a priori* methods limit the ways that things could be that we are then able to determine what is actual. The examples he makes use of are the atomic number of the element gold, 79, and the identity theory, in which mental states are thought to be identical to brain states (Tahko 2012, 39-43). I will only discuss the first case.

There is an infinite range of the metaphysically possible and impossible correlations between the number '79' and the element gold (*Au*). Tahko suggests that due to our limited abilities we must limit the range of possibilities if we are to make any scientific progress (Tahko 2012, 40). By using *a priori* analysis to first limit these possibilities, and then using empirical research, we are capable of making progress with respect to our understanding of the element gold. In other words, there is an *a priori* basis for our understanding of the world which may be dependent upon something like the law of excluded middle ( $\Box (\neg p \vee p)$ ).

Setting aside logical laws, we come to understand how to limit the range of possibilities in different contexts by having different experiences. It is very well possible that chemical elements were assigned atomic numbers on the basis of their number of neutrons instead of number of protons in the nucleus. This approach to delimiting the possible numerical assignments for chemical elements would yield the number '12' for both sodium (*Na*) and magnesium (*Mg*). Given that both sodium and magnesium produce very different results, it

would be a mistake to think that they are the same element. It would be the actual conditions, then, that can be identified as determining how to go about limiting possibilities. If we are to adopt Tahko's argument, then we should claim that actuality precedes epistemic possibility. But I think making this general of a claim is also a mistake, instead the contexts and our intentions will shape what counts as the relevant resources and methods for delimiting the range of possibilities to better understand what is actual. It just so happens that the refinement of these methods will be dependent upon what is actual.<sup>60</sup>

This blurring of what counts as *a priori* is in line with the observation that it is no longer clear what counts as empirical research since so much research no longer only uses observations and it is not clear exactly what counts as an observation.<sup>61</sup> In understanding how scientific activities are a conglomerate of the *a priori* and *a posteriori* we can better understand how metaphysics in many ways provides support for scientific activities, while being malleable in light of scientific developments.

### 3.3.3 Is Neo-Aristotelian Metaphysics Naturalizable?

The neo-Aristotelian characterization of metaphysics as first philosophy understandably leads neo-Aristotelians such as Fine (2012), Lowe (2006), and Tahko (2012) to maintain that metaphysics is a necessary precursor to scientific activities. The preceding section, however, has posed challenges to Tahko's suggestion that Aristotelian metaphysics is naturalized because it is continuous with and provides an *a priori* foundation to science. Although these challenges pose problems to the claim that Aristotelian metaphysics is naturalized, some consideration should be given to the possibility of Aristotelian metaphysics being naturalized.

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<sup>60</sup> Much of this discussion traces the lines drawn by the foundationalist and contextualist debate in epistemology.

<sup>61</sup> This is a similar issue for constructive empiricists in determining *empirical adequacy* (Monton and Mohler 2014).

The possibility of Aristotelian metaphysics being naturalized has been given some consideration by Ladyman and Ross. In particular, they concern themselves with the extent to which neo-Aristotelians have informed themselves of recent developments in physics. They maintain that neo-Aristotelianism is at best philosophy of “Grade A” science (Ladyman and Ross 2007, 24). Instead, metaphysicians should include contemporary scientific developments. The result being, they claim, is that we no longer have an ontology of things, but of structures. This result indicates that our understanding of reality requires revision.

Tahko shares their concerns with the naturalizability of Aristotelian metaphysics when he asks “Can we reconcile Aristotelian metaphysics with [Ladyman and Ross’] idea of naturalized metaphysics?” (Tahko 2012, 33-34). He suggests that it is a mistake to rebuff Aristotelian metaphysics on the basis of its origins being at odds with scientific developments (Tahko 2012, 34). Although Ladyman and Ross discuss the results of having adopted one metaphysical approach over others, their concern is mostly epistemological; they are centrally concerned with what should count as evidence for endorsing a metaphysical claim. Specifically, they object to the Aristotelian’s use of *a priori* intuitions. It is this objection that motivates Tahko’s emphasis on metaphysics being used to establish an *a priori* basis for scientific inquiry, which I have already discussed in detail above. Although I am mostly sympathetic to Ladyman and Ross’ objections, my concern is with the general methodology that neo-Aristotelians employ. In particular, my concern is with the extent to which neo-Aristotelian metaphysics is naturalizable while remaining part of the Aristotelian lineage.

As I mention in the Chapter 2, the neo-Aristotelian adopts Aristotle’s method of starting from common sense and developing metaphysical theories that accord with commonsense observations. There is a conflict that arises, though, when we attempt to use this method of

maintaining accordance with commonsense observations while updating our metaphysical theories to accommodate naturalistic developments. This is a conflict that arises directly from Aristotle's own methodological considerations in his discussion on the generation of bees. He writes,

Such appears to be the truth of the generation of bees, judging from the theory and from what are believed to be the facts about them; the facts, however, have not yet been sufficiently grasped; if ever they are, then credit must be given rather to observation than to theories, and to theories only if what they affirm agrees with the observed facts. (Aristotle *Generation of Animals* Book III CH. 10 760b28-33)

More importantly attenuated methodological naturalism would recommend suspending judgment to those metaphysical projects that are at odds with scientific developments. As the above sections illustrate, there are naturalistic developments in both physics and biology that are at odds with the neo-Aristotelian's conception of substance, which is a key feature of that metaphysical framework.

The difficulties can be summarized as follows. To naturalize metaphysics would involve taking into account both the theoretical and observational aspects of the theories developed from the best contemporary physical and life sciences. To engage in (neo-)Aristotelian metaphysics is to give priority to observational facts and to suspend judgment on those theories that are at odds with the observational claims. Therefore, (neo-)Aristotelian metaphysics is fundamentally at odds with a naturalized metaphysics and, thus, is not naturalizable.

Tahko states that it is problematic to look to Aristotle to determine whether or not neo-Aristotelian metaphysics is naturalizable, "[If] we consider Aristotle's ideas in his *Physics* for instance, most of them seem rather obsolete. No philosopher in Aristotle's time could have

realized just how small and strange the world of subatomic particles is, or indeed how vast and old the universe is” (Tahko 2012, 33-34). Our understanding of the subatomic features of the world and the age of the universe, however, does not result from purely *a priori* or common sense reflections. Instead, they are sophisticated theoretical developments resulting from a combination of both empirical and mathematical approaches to understanding the natural world. To dismiss Aristotle’s physics is to loosen the constraint on the roles that the *a priori* and commonsense observations have in constructing metaphysics theories.

Loosening this methodological constraint has dire implications for neo-Aristotelianism in general. If the neo-Aristotelian begins naturalizing her metaphysics, then she will need to take into account contemporary developments from the natural and life sciences. As the previous discussion shows, however, doing so results in questioning the neo-Aristotelian account of SUBSTANCE. The category SUBSTANCE, however, is the fundamental category upon which neo-Aristotelian metaphysics depends. For this reason, attempting to naturalize neo-Aristotelian metaphysics results in the possibility of undermining the entire neo-Aristotelian framework. To not question the account of substance, however, for fear of the unraveling of the metaphysical framework, is to not consistently adhere to the naturalistic enterprise. The resulting dilemma being that if neo-Aristotelian metaphysics is naturalizable then it must suspend judgment with respect to the concept of substance, but to not suspend judgment to the concept of substance is to not be engaged in naturalization. Therefore, we have reasons to believe that neo-Aristotelian metaphysics is not naturalizable.

### **3.4 Conclusion**

To sum up: This chapter has evaluated neo-Aristotelian metaphysics, and substance metaphysics more generally, given the adoption of attenuated methodological naturalism. Whereas the

adoption of Papineau's formulation of methodological naturalism would warrant the rejection of neo-Aristotelian metaphysics, since their concept of substance is undermined by contemporary science, the attenuated formulation of methodological naturalism only requires that we suspend judgment with respect to its truth. This has two benefits: First, it allows substance metaphysics to still be pursued as a working hypothesis. Second, it provides justification for pursuing those metaphysical theories that are not taken to be the received view in contemporary analytic metaphysics. In the next chapter I will consider one of these metaphysical theories—process metaphysics.

## CHAPTER 4: AN ONTOLOGY WITHOUT SUBSTANCE

### 4.0 Introduction

The developments in this dissertation have, thus far, been mostly critical. To review, Chapter 1 offers criticisms of some formulations of methodological naturalism to allow the pursuance of metaphysical projects *even if* they are at odds with contemporary naturalistic claims. Chapters 2 and 3 provide *prima facie* and naturalistic reasons, respectively, for questioning the general bases of substance metaphysics of the sort that neo-Aristotelians defend.

The present chapter is a positive contribution that undertakes to show that we have reasons for not rejecting process metaphysics out-of-hand, which I believe has been the case for those who associate process metaphysics with Whitehead (1978). After providing a brief historical survey of process metaphysics (4.1), I will argue that we have reasons for further pursuing process metaphysics by taking into account naturalistic considerations (4.2) from both physics (4.3) and biology (4.4).

### 4.1 A Brief History of Process

A metaphysics of substances has been the standard approach in the Western philosophical tradition.<sup>62</sup> This, however, has not been the only metaphysical account available; there are also process accounts. Whereas substance metaphysicians argue that reality is fundamentally comprised of distinct individuals that endure through time and undergo change, process

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<sup>62</sup> I emphasize 'Western' since Eastern philosophical traditions such as those developed by Confucius, Aurobindo, and Lao Tzu are not clearly substance-based. See Tu (1979), Aurobindo (1974), and (Legge 1891).



metaphysicians hold that reality is a complex configuration of interacting processes. Whitehead's account of process metaphysics is among the most well known in the 20<sup>th</sup> Century. It is unclear, though, exactly why process metaphysics has been given such little attention in contemporary analytic metaphysics.

One possible explanation is the mixed reception of Whitehead by some canonical analytic thinkers. For example, his former students, Davidson and Quine, both expressed reservations about Whitehead's philosophy.<sup>63</sup> Quine indicates that although he understands he was in the presence of someone great, he was disappointed in the shift Whitehead had made in his philosophical development after the *Principia*. Quine writes,

Whitehead lectured on *Science and the Modern World* and on *Cosmologies Ancient and Modern*. I responded little, even after accustoming myself to his accent. What he said had little evident bearing on the problems that I recognized. His hours were mercifully short and his speech exasperatingly slow. My notes were crowded with doodles. For a term paper I took refuge in his relatively mathematical material on "extensive abstraction." But I retained a vivid sense of being in the presence of the great. (Quine 1986, 9-10)

Davidson offers a less flattering assessment of his experiences with Whitehead.

I have often thought my encounter with Whitehead set me back philosophically for years; he confirmed my inclination to think that doing philosophy was like writing poetry: anything, as long as it sounded important and mysterious, was as good as anything else (this is unfair to poetry). Truth, or even serious argument,

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<sup>63</sup> Whereas Quine wrote his dissertation under Whitehead's direction, Davidson only took courses with Whitehead as an undergraduate.

was irrelevant. You didn't even have to be a good poet: a little flair and you were at the top, with an A+. (Davidson 1999, 14)

Furthermore, although this point is not explicitly stated in the literature, much of the recent resistance to process metaphysics appears to result from associating Whitehead with theological and theosophical developments of process philosophy found in the works of Hartshorne (1970).<sup>64</sup> But the outright rejection of process metaphysics by contemporary philosophers may only be a rhetorical device constructed by process metaphysicians. Rescher is wary of this criticism when he claims that “we are actually witnessing such a revolt [against process]—that I am not contesting a merely straw-man position—is readily established” (Rescher 1962, 411). Among the sources that Rescher surveys we find Goodman (1951), Quine (1960), and Strawson (1959). Rescher suggests that since their discussions emphasize a thing-oriented ontology, without giving consideration to a process-based ontology, they reject a process-based ontology. But the preference for adopting a thing-oriented ontology is a result of commonsense observations of our language, in the case of Quine, and objects, in the case of Strawson. They do not develop a thing-oriented ontology by rejecting processes; as even Rescher (1962, 11) points out, Quine and Strawson do not even consider the possibility of process metaphysics. It does not appear, then, that contemporary metaphysics is a “revolt against process” in the way that Rescher envisions; instead, it appears that process metaphysics has simply been ignored.

Even if there is no clear and decisive objection to process metaphysics, the tendency to think of process metaphysics as requiring a theological interpretation is misplaced. As Rescher illustrates, there have been both theological and naturalistic approaches to developing a process

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<sup>64</sup> This resistance has become evident in conversations with other metaphysicians.

metaphysics. In the latter, “[n]atural processists...view the world as a self-sufficient and self-managing system” (Rescher 1996, 154). This naturalistic account is the sort of process metaphysics that Heraclitus arguably had in mind in his poetic responses to his Ionian predecessors, when he suggests that the cosmos is not created but “[t]his world-order, the same of all no god nor man did create, but it ever was and is and will be: ever living fire, kindling in measures and being quenched in measures” (Heraclitus Fragment B30 quoted in Graham 2006, 135). In the Modern era, although Leibniz’s relationalism and dynamics have theological aspects (Leibniz 1989, 1989a, 1989b, 1989c), his rationalist inclinations provide a basis for the process accounts found in McTaggart, Russell, and Carnap (Simons 1987, 123 n.42). Furthermore, pragmatic considerations figure prominently in the process accounts that Nietzsche, Bergson, Peirce, James, Dewey, and Mead have offered, in which *lived experience* is a general theme (Browning and Myers 1998). So, even though process has not found widespread reception in contemporary analytic metaphysics, there are numerous historical attempts to develop process metaphysics without relying upon theological commitments.

Process metaphysics is not only a historical curiosity, though. Both Sellars (1981) and Rescher (1996) have made more recent attempts to develop substantive aspects of process metaphysics. Rescher’s own theological sympathies have likely caused his account to be taken less seriously, for reasons similar to those hindering the reception of Whitehead. Although Sellars made some attempts to develop process metaphysics while incorporating naturalistic considerations, this aspect of his work has received little attention even from his most ardent enthusiasts (e.g., McDowell (2009) and Brandom (2009)).

Outside of discussions in general metaphysics, Salmon (1984) has attempted to develop an account of scientific explanation that makes use of process metaphysics. In particular, at odds

with a Whiteheadian process metaphysics that understands events, or “occurrents,” as being fundamental, Salmon’s account places processes as being more fundamental than events (Salmon 1984, 23). He claims “[t]he main difference between events and processes is that events are relatively localized in space and time, while processes have much greater temporal duration, and in many cases, much greater spatial extent” (Salmon 1984, 139). A characteristic trait of process metaphysics, which I believe detracts from its serious consideration, is the lack of there being a rigorous definition of ‘process’.

Often ‘process’ is taken as basic, or, as Salmon’s own method illustrates, process metaphysicians extensively rely upon examples. For instance, “[a] baseball colliding with a window would count as an event; the baseball, traveling from the bat to the window, would constitute a process” since they have different “lengths” along a spacetime line (Salmon 1984, 139).<sup>65</sup> Although his account has gained some traction in discussions on scientific explanation, Salmon’s more general metaphysical account of processes has received little consideration. It is particularly difficult to determine the extent to which an event is distinguishable from a process if their only differences are their lengths along a spacetime line. An ontology that makes distinctions between the two will need to offer a more precise account since it is possible for two narratives referencing the same spacetime line to result in conflicting assessments. Considering processes in the context of scientific explanation, however, does provide intuitive motivation for naturalistically developing process metaphysics.

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<sup>65</sup> These examples have difficulties swaying those who are not already sympathetic to a process metaphysics since these “processes” are described in terms of *things* participating in processes without showing that these general processes are themselves metastable configurations of interacting processes. This issue will be further discussed in the next chapter on *structure*, in which something like a baseball can be given a process description.

## 4.2 Naturalism and Processes

Campbell (2009), Dupré (2012), and Seibt (2002) each contribute substantively to the recent trend of adopting naturalistic methods for developing process metaphysics. Notably, Seibt, who is a former student of Rescher and Sellars, recognizes the “dominant substance-gear paradigm of Western metaphysics” and understands that making process metaphysics palatable to those in the mainstream analytic tradition will require close engagement with substance metaphysics. For these reasons, she proposes three claims for the successful development of process metaphysics (Seibt 2012):

*Claim 1:* Illustrate that the basic assumptions of substance metaphysics are dispensable.

*Claim 2:* Show that process-based theories perform just as well or better than substance-based theories in application to the familiar philosophical topics identified within the substance paradigm.

*Claim 3:* Argue that there are other important philosophical topics that can *only* be addressed within a process metaphysics.

Chapters 2 and 3 work towards establishing Seibt’s first claim by illustrating how there are both *prima facie* and naturalistic reasons for dispensing with, or at least not fully endorsing, basic assumptions of substance metaphysics of the form that neo-Aristotelians defend. My arguments in those chapters, however, only offer reasons for questioning their basic assumptions, without providing the basis for a full-blown rejection of substance metaphysics. Specifically, my arguments indicate that there are lingering problems with substance metaphysics that warrant us not being fully committed to its framework. We can then infer that those assumptions are dismissible insofar as we have reasons to not accept substance metaphysics as being true.

Though dispensing with the basic assumptions of substance metaphysics might seem a sufficient basis for pursuing process metaphysics, this is not obviously the case. It is possible that those *prima facie* and naturalistic reasons given in previous chapters for questioning substance metaphysics are also reasons for not pursuing a process framework. In that case, we would have reasons for not accepting any metaphysical framework or seeking a third option. Since I do not believe that we can have knowledge without some metaphysical framework, and we know there is something (e.g., there is a world), the first option is untenable.

Second, there does not appear to be a third candidate readily available. Still, some comments should be made about why there is no third alternative. In Lowe's discussion of substances comprising our fundamental ontology, he considers states-of-affairs and tropes as potential alternative accounts, either of which would be a third alternative to substances and processes. Both of these alternatives, however, depend upon the general idea that reality is comprised of discrete and static individuals (i.e., they remain committed to an underlying metaphysics of substances).

This conception of reality is found in Armstrong (1997) who claims that the basic constituents of reality are states-of-affairs, which are understood in terms of relationships instantiated by universals and their respective particulars. These relationships require that a universal and particular be independent of one another. A universal is an independent and static individual of which its particular is an instance. Yet, this is the very sort of independence that I have already argued against in showing why a neo-Aristotelian account of substances is inadequate. My argument, however, specifically critiques the neo-Aristotelian's account of universals since the existence of the universal is contingent upon its instances. A Platonist

conception of universals, of the kind that Tooley (1977) advocates,<sup>66</sup> might fare better in this regard. The Platonist allows universals to exist outside of space and time, and an account that makes use of such universals does not require those universals being dependent on anything else—thus, avoiding the criticisms levied against universals in earlier chapters.

The issue of universals is far from being settled and there remain many criticisms of Platonic universals. What I believe to be most damaging is the one-over-many-problem. Although there are discrepancies over its formulation,<sup>67</sup> the problem highlights the difficulty of accounting for different tokens being identical in their different instantiations of the same type. A second difficulty is to provide an account of how we can have epistemic access to universals, given that they are spatio-temporally isolated from our sensory and cognitive faculties. Neo-Aristotelian accounts of universals may resolve these problems by identifying universals through their instantiations, although doing so results in its own set of difficulties, but the Platonist's account appears to be ensnared in its own difficulties by virtue of having universals existing independent of space and time. For these reasons, until the above problems are resolved, it is not obvious that an ontological account that makes use of states-of-affairs is any more promising than other ontological accounts that have their own difficulties.

Furthermore, trope theorists (e.g., Campbell (1991)) suggest that reality is comprised of particular properties of which some specific formulations are developed in an attempt to overcome the problems facing substance views (e.g., Simons (1994)). Tropes, however, should not be thought of as being processes—even though they do not take fundamental substances as being the basic constituents of reality. A theory that makes use of tropes is saddled with its own

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<sup>66</sup> Armstrong has argued for different accounts of universals. In Armstrong (1978) he argues that all universals must be instantiated, although later in Armstrong (1997) he allows the possibility of uninstantiated universals.

<sup>67</sup> See Rodriguez-Pereyra (2000).

difficulties, which I will not belabor here. Among these, though, is the idea that any property can exist independently of an object that exhibits that property. This is an analogous difficulty to the one I mention in the previous chapters of having individual substances existing independently of their properties, since we only come to know objects through their characteristics. In the case of trope theories, the problem is reversed. Since we only come to know properties through the objects to which they are ascribed, some account needs to be given as to how those properties are not ontologically dependent upon their respective objects. This problem is an analogue to the neo-Aristotelians' problem of accounting for the ontological independence of substances.

Given this brief sketch of some other candidates for developing an ontological framework, it is clearer how the other alternatives to neo-Aristotelian substance metaphysics are themselves characterized in substance based terms; both states-of-affairs and trope theories are dependent upon there being static individuals. For these reasons, then, it is clearer why the general ontological debate in contemporary analytic metaphysics can be framed as a dispute between substance and process metaphysics.<sup>68</sup>

It is still not obvious, though, that we have independent reasons to pursue process metaphysics despite the general ontological debates having been framed in terms of adopting either a substance or process metaphysics, and the previous chapters having shown that we have reasons for suspending judgment with respect to the adoption of substance metaphysics. There is still the lingering possibility that the *prima facie* and naturalistic reasons given for suspending judgment on substance metaphysics are themselves reasons for suspending the acceptance of

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<sup>68</sup> There may be another alternative, *concrete universals*, which provides an account of universals in terms of their historicity (Hegel 1975). This account, however, has not been discussed in the recent debate on analytic ontology. For this reason, I will not further discuss this option here.



process metaphysics. As I will discuss below, the reasons given for suspending judgment on substance metaphysics turn out to be positive reasons for further pursuing process metaphysics.

It is also possible that process metaphysics is saddled with as many, if not more, difficulties as the substance-based theories that I briefly canvassed. Given that there are advocates of these major theories, and it is very well possible that their difficulties arise from having adopted substance metaphysics, their general pursuance to develop a cohesive ontology indicates that process metaphysics is also worth pursuing despite some of its difficulties. This claim, of course, depends upon the presupposition that any kind of metaphysics is worth pursuing.

By arguing that we have reasons to pursue process metaphysics, this chapter serves as a foundation for the next chapter in which I will specifically address Seibt's second claim—namely, that process metaphysics does no worse than substance metaphysics in solving problems in metaphysics. To show that the process metaphysician can make progress where substance metaphysicians have, I will develop a process account of *structure*. I should also briefly state that I will not be developing her third claim in this dissertation—namely, that some important topics can *only* be properly addressed by process metaphysics. I think that, although there may be some philosophical problems that will only positively benefit from developing a process framework, I believe that the negative results from pursuing substance metaphysics are themselves worthwhile results for better understanding the world.<sup>69</sup>

I briefly mentioned above that most process metaphysicians either treat processes as basic or use examples to define what processes are. Seibt, however, provides the clearest account of 'process' in the literature while engaging with naturalistic developments. This approach to

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<sup>69</sup> This claim is consistent with general scientific practice.

developing an account of processes is a promising approach to generating support for pursuing process metaphysics. For this reason, I will be adopting her formulation of processes, which consists of six features (Seibt 2002, 86):

1. Concrete or spatio-temporally occurrent
2. Individuals
3. Dynamic stuffs
4. Non-particulars or multiply occurrent
5. Not fully determinate
6. Not directed developments (events) but are dynamically homonomous

Seibt's account shares with Salmon's account the thesis that processes are ontologically primary to events. By only appealing to their lengths in spacetime, Salmon's account fails to explain in which sense processes are more fundamental. Seibt, however, fares better in this regard.

Processes for her are individuated by their "descriptive thisness" instead of "spacetime location" (Seibt 2002, 85). She then accounts for our commonsense observations of what counts as an event by employing a non-transitive part relation, which allows us to understand processes as being parts of other processes without being "a part of" other processes (Seibt 2002, 85 n. 58; emphasis in original). For example, the way (or mode) that the process is part of some other processes determines the mode of the first process, which allows for some processes to show up as events, while other processes may be taken as states-of-affairs, tropes, or things.<sup>70</sup> On Seibt's view, then, events are understood as particular types of processes without requiring all processes be events. The benefit of this approach is that a monocategorical ontology (Seibt 2003), being

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<sup>70</sup> In the next chapter, this mode will be described in terms of metastability conditions for describing different kinds of structures.

comprised of only processes, can explain events without reducing processes to a series of events in the way that Whitehead (1978) envisions while also avoiding the problems that Salmon's account faces.<sup>71</sup>

In defending the claim that we have reasons for pursuing process metaphysics of the sort that Seibt puts forward, and that the naturalistic reasons given for questioning substance metaphysics are not reasons for questioning process metaphysics, I will first discuss the ontological interpretations of QFT that were given consideration in the discussion of substance metaphysics (4.3) and then will discuss evolutionary biology (4.4). My aim will be to show that both scientific theories benefit from a process interpretation while contributing to the justification of further pursuing process metaphysics. This approach is consistent with attenuated methodological naturalism, which indicates that we should take into account naturalistic developments when pursuing a metaphysical framework. Doing so will allow us to determine if the sorts of reasons that demand the suspending of judgment on the truth of substance metaphysics will also prompt us to suspend judgment with respect to the viability of process metaphysics.

### 4.3 Quantum Field Theory

In this section, I will illustrate how the current status of the three main ontological interpretations of QFT (*trope*, *invariant factors*, and *process*), provide support for adopting a process interpretation.<sup>72</sup> It is important to notice that these three are metaphysical accounts deriving from particular reactions to developments in QFT. For this reason, both metaphysical considerations

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<sup>71</sup> Campbell (1991) also suggests that a trope ontology is a "one-category ontology."

<sup>72</sup> There are also modern logic-linguistic, individual, and fact interpretations of QFT. These, however, are not given serious considerations in the debate on the appropriate ontological interpretation of QFT. For this reason, I will not discuss these interpretations.

and an understanding of the details of quantum field theory are needed to account for the superiority of one interpretation over others. My task here is only to address the first component. In doing so, I will adopt Paul's (2012) recommendation that an adequate metaphysical account must involve explaining both our phenomenal experiences and their underlying structure as described by science.

Chapter 3 argues that neo-Aristotelian substance ontology is at odds with three contending ontological interpretations of QFT: quanta, tropes, and processes. This claim is consistent with expositions by proponents of each of these interpretations, which I will briefly summarize here. Teller (1997) upholds a quanta interpretation, which moves away from the view of individual particles exhibiting "primitive thisness" as things that are capable of being counted in the way that a substance interpretation suggests. Instead, he claims that particles are to be understood in terms of *quanta*, which are susceptible to aggregation, allowing us to measure the amount of quanta present without knowing their individual locations.

Kuhlmann (2002) also maintains that substance-based ontology is untenable given developments in QFT. His account, however, makes use of tropes without fully fleshing out the details of what a trope theory interpretation would look like. He only states that a trope ontology is "a more promising candidate" than a process or invariant factor ontology in assisting us understand QFT (Kuhlmann 2002 et al., 109).<sup>73</sup> The reasons that he offers for preferring a trope ontology to others will be discussed below, but intuitively it would seem that a trope theory is adequate for explaining QFT since, at least in its algebraic formulation, QFT can be understood as describing and measuring local groups of quanta in a manner similar to the accounts

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<sup>73</sup> He specifically mentions that an algebraic approach will benefit from a trope ontology, although he does not explain why he thinks this.

developed by trope theorists who understand local objects as being comprised of bundles of properties.

Following the lead of Teller and Kuhlmann, Seibt (2002) argues that a substance-based interpretation of QFT is not preferable to any of its rivals. Contrary to them, though, she argues that processes best accommodate QFT. I will have more to say on how she develops a process-based account, but it is first important to note that in considering which of these interpretations we should prefer, Seibt highlights some of the difficulties in adopting Teller's argument for quanta. In particular, she argues that his shift to focusing on quanta being "aggregable" instead of countable not only strips away the primitive thisness of classical particles, but also their particularity and discreteness (Seibt 2002, 78). Teller's account of quanta, however, requires them to be particular and discrete. For this reason, Teller's account is self-undermining.

At this point, then, it would appear that we only need to consider trope and process interpretations, since the general metaphysical debates can be framed in terms of a choice between adopting either a substance or process framework. Although these will ultimately be the two primary candidates for discussing interpretations of QFT, since trope interpretations are representative of a substance framework and process interpretations are representative of a process framework, some consideration needs to be given to Simons' (2002) account in which he develops an ontology of *invariant factors* that further highlights the inadequacy of developing a substance model of QFT. Since those who actively pursue developing an ontological interpretation of QFT agree that substance ontology is not a suitable candidate, and there are reasons for not further developing a quanta interpretation of the sort that Teller offers, I will only discuss tropes, invariant factors, and processes as candidate interpretations.

### 4.3.1 Tropes

Kuhlmann defends a trope theory as being the appropriate interpretation of QFT. In doing so, he adopts a “nuclear theory” of tropes.<sup>74</sup> On this view, there are things in the world that are not themselves tropes, but can be explained in terms of tropes—that is, tropes are the *fundamental* constituents of reality. What sets the nuclear theory apart from other (classical) trope theories, which resemble the sort that Hume offers (Hume 1978, 207), is that in the nuclear theory objects are comprised of a core bundle of essential tropes that is surrounded by variable tropes (Simons 1994). Kuhlmann maintains that fundamental tropes are those tropes that correspond to “elementary quantum objects” (Kuhlmann et al. 2002, 106). All other tropes are used for the purpose of developing a general trope ontology (Kuhlmann et al. 2002, 107).

The development of a “nuclear tropes-only ontology” (Kuhlmann et al. 2002, 107) appears to be an acceptable ontology since it is able to accommodate many aspects of quantum theory and is able to overcome some objections that traditional trope theories face. By having a correspondence relation hold between allegedly fundamental quantum properties (e.g., charge and spin) and fundamental tropes, Kuhlmann’s account is informed by some naturalistic developments that are potentially problematic for substance views. Furthermore, a common objection to trope theories is the boundary objection, namely the difficulty of accounting for the boundary of a trope. The nuclear theory can avoid this difficulty by defining the boundary of a trope in terms of an object’s fundamental quantum constituents; the boundaries of those constituents will be the boundaries of the tropes that form an object.

The nuclear theory is also preferable to other attempts to overcome the boundary objection. For example, Campbell (1991) maintains that a trope is fundamental only if it spans

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<sup>74</sup> He adopts this account of tropes from Simons (1994).

the entire universe. This “field” account has the counterintuitive result that things spanning the entire universe provide explanations for what appear to be only local objects. Kuhlmann’s account, by appealing to quantum properties as being fundamental, allows local objects to explain local phenomenon, which is in-line with our intuitions about what is involved in offering an acceptable explanation.<sup>75</sup>

Despite these benefits, there are reasons for not accepting Kuhlmann’s account. First, it does not adequately respond to the challenge of the trope theorist needing to give an account of how properties can exist independently from their respective objects. The nuclear theory of tropes partially responds to this issue by having objects possessing a core made up of codependent essential tropes that are surrounded by variable tropes. But it would then seem that the only tropes we directly experience are variable tropes. Yet the essential tropes are what allow a thing to maintain identity despite some modification in the arrangement of its variable tropes. In our experience, however, it seems that we are interacting with things as they really are. But if we are only interacting with variable tropes, then we are never interacting with the essential aspects, but only accidental features of those objects. Without interacting with the essential aspects of an object, it is difficult to provide the appropriate distinguishing conditions for each of those objects. The lack of these conditions provides obstacles for developing an accurate account of what exists, which is one of the main goals for developing an ontology.

Second, it is unclear how the nuclear theory of tropes is capable of accommodating fields as described in QFT.<sup>76</sup> At least on Campbell’s formulation, a more traditional account of tropes

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<sup>75</sup> This claim is dependent upon the assumption that explanations are aimed at contributing to understanding; an explanation that requires appealing to the whole universe does not contribute to understanding since our finitude prevents us from understanding the entire universe. A similar problem arises in consideration of the ontology of invariant factors, which I discuss below.

<sup>76</sup> Kuhlmann appears to be aware of this concern when he does not take a stance on tropes being field-like (Kuhlmann et al. 2002, 107).

is better able to accommodate the general idea of fields since fundamental tropes are understood to span the entire universe. This approach, however, results in unintuitive resolutions to the boundary problem since the only boundary is the universe. Whereas the adoption of the nuclear theory of tropes appears better capable of responding to the boundary problem by defining boundaries in terms of quantum properties, the requirement of a core essential bundle appears to generate similar difficulties of reconciling a substance-based ontology with QFT. In particular, the supposition of discrete bundles that contain essential tropes requires a way that those bundles are distinguishable from other essential tropes; otherwise, it is unclear what it means for some bundle of tropes to be essential for one object and not another.

These essential tropes, however, are not able to capture what is ontologically fundamental in the way that Kuhlmann claims that a trope interpretation of QFT can. If quantum properties are taken to be fundamental, then it is those fundamental properties that explain what is essential. Yet what is essential for something to be what it is does not entail that those essential properties are themselves fundamental properties. As mentioned above, Kuhlmann claims that quantum properties are fundamental tropes. Since material objects are comprised of these tropes, they are necessary for material objects to exist. Kuhlmann, however, does not believe that the only things that exist are tropes—only that everything can be explained in terms of them. This possibility allows for things to be distinguishable from others in the same way that we distinguish medium-sized objects. The way that we distinguish them, however, does not involve distinguishing them in terms of their fundamental quantum properties since doing so is an impossible task. Instead, we are more inclined to distinguish things in terms of what we take to be essential. Since what we believe are essential properties for the purposes of distinguishing items are not quantum properties, these essential properties are not fundamental in Kuhlmann's sense of *essential*.



### 4.3.2 Invariant Factors

In addition to these difficulties, Simons (2002) rebuffs the possibility of a trope theory providing the appropriate interpretation of QFT. Simons, whose earlier papers on tropes are partly responsible for Kuhlmann's own trope sympathies (Kuhlmann 2002, 104),<sup>77</sup> objects to developing a trope-based ontology for QFT. Simons' main objection to trope theory is similar to my own in that a trope depends upon something independent—even if that is the world (Simons 2002, 44). In its place, he recommends an ontology comprised of, what he calls, *invariant factors*. This ontology is the result of designing an information handling software ONTEK intended to simulate distribution of information between managers and employees, which includes basic factors, or *modes*. These modes are divided among eleven families, *modal dimensions*, which result in a combination of 3,072 kinds (Simons 2002, 48). There are three notable aspects of this ontology: the size of the ontology prevents it from being observed by individuals; the ontology is a result of developing a formal framework for software; and it is not the result of philosophical reflection but of a collaboration among programmers.

The motivation for this software project, however, was not to develop an ontology but to develop artificial intelligence for the purposes of emulating the distribution of information by managers. The ontological components appear to be an afterthought. Furthermore, approaching metaphysics this way is at odds with Simons' own recommendation for how metaphysics should be done: "revisionary metaphysics need not and should not lose its anchorage in common sense and science: that are its 'reality checks'" (Simons 2002, 47). Since it is not possible for an individual to understand the ontology itself, it appears that this approach to developing an

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<sup>77</sup> Kuhlmann especially references Simons (1994 and 1998) as having influenced his adoption of the atomic theory of tropes.

ontology is at odds with common sense. Understanding, however, plays a significant role in justifying the development of an ontology. This is a point at which Kuhlmann criticizes Simons' ontology, since Simons' ontology is the result of using computational models to calculate an ontology and “computers do not try to understand anything” (Kuhlmann 2002, 108).

Rejecting the invariant factor ontology may result only from it not meeting our aesthetic preferences for parsimony. Another reason for not preferring it to other ontological interpretations of QFT is that despite its ability to accommodate much of the mathematics of QFT, no test has been performed to determine if the formal framework of the ontology of invariant factors is sufficient for understanding QFT. Yet, Simons maintains that such a test is needed to adopt an ontology of invariant factors (Simons 2002, 50). Without such a test we are left with a formal framework that has a dense ontology, which is at odds with common sense and has not been confirmed or tested by science—the very two anchors that Simons believes serve as “reality checks” for an ontology. At this point of the discussion, then, an ontology of invariant factors is not a viable substitute for a trope interpretation of QFT, which is itself inadequate.

### 4.3.3 Processes

Along with Simons, Seibt (2002) rejects the possibility of a trope theory providing the appropriate interpretation of QFT. Seibt, however, appears at least more sympathetic to the prospect of developing a trope ontology for QFT (Seibt 2002, 79). Tropes are still countable individuals, which maintains some of our intuitions about what objects are. Furthermore, tropes appear versatile enough to accommodate both our intuitions and scientific developments. Tropes can form complex trope structures that can accommodate our intuitions about things, while also serving as the basic fundamental building blocks of reality in the way that Kuhlmann recommends. Even though Seibt acknowledges the possibility of pursuing a trope-based

ontology, she does not believe that we should accept a trope interpretation (Seibt 2002, 82). In order to accept a trope ontology, it still needs to overcome significant difficulties—namely, its inability to form a coherent account of what it means for a trope to be individual, dependent, and particular.

In place of trope ontology, Seibt argues in favor of a process interpretation of field quanta. Seibt's account, *Axiomatic Process Theory* (APT), first aims to move away from substance ontology.<sup>78</sup> Although the idea that reality is fundamentally comprised of free processes is in many ways counterintuitive, the theory aims to incorporate many of our commonsense observations of stuffs (e.g., fire) and activities (e.g., running). The key distinction between a particle- or thing-based ontology and a process ontology is that, while particles are understood as being individuals, particulars, and countable, processes are individuals, while being neither countable nor particular. This distinction may initially appear at odds with our intuitions about what it means to be an individual. Yet, as Seibt indicates, both smiles and opportunities are countable without being particulars (Seibt 2002, 83). A smile depends upon a particular face being configured in a recognizable way, while an opportunity is dependent upon environmental and social factors standing in relation to a person who is capable of recognizing the opportunity as such. Although we can count smiles and think of opportunities lost, they do not exist independently of their configurations and situations—a necessary prerequisite for being a particular.<sup>79</sup>

While free processes have in common with smiles and opportunities being individuals, free processes lack the ability to be counted in a similar way to how descriptions of weather

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<sup>78</sup> In Sellarsian fashion, she refers to the assumption of substance ontologies as the “Myth of Substance” (Seibt 1996).

<sup>79</sup> The idea that free processes are not particulars is what primarily distinguishes APT from a Whiteheadian process metaphysics, in which particular occasions are the fundamental ontological constituents (Seibt 2002, 82).

activities (e.g., ‘it is raining’) are incapable of being counted. Instead of the ‘it’ being an indicator of a thing, the ‘it’ indicates that there is currently a going-on (i.e., activity). The activity, as a whole, is incapable of being counted, while some parts understood in terms of accomplishments (e.g., events or occurrences) may be counted. These accomplishments, however, are the result of the interactions of noun-countable processes.

In summary, free processes are individuals since we can reidentify them in different circumstances; we can reidentify a process of raining despite spatiotemporal differences. Furthermore, free processes are like-parted; every spatiotemporal region of raining is a region where there is also raining. While the general process of raining, as it happens, is uncountable, each of its regions is capable of being counted as a region. Yet, each region is itself comprised of additional processes that are themselves not countable. These features of processes motivate the fundamental assumptions of APT: (i) any non-countable entity is itself the result of interactions of non-countables and (ii) any countable entity is itself the result of interactions of non-countables (Seibt 2002, 84).

It is important to note that none of the above ontological interpretations of QFT have been worked out in detail. Yet, there may be some intuitive ways to make sense of key concepts such as *field* and *quanta* within a process framework since both of the fundamental assumptions of APT capture some key aspects of fields and quanta. As Auyung discusses, there are at least two senses of ‘field’: a field is either “a continuous dynamical system or a system with infinite degrees of freedom” or “a dynamical variable characterizing such a system or an aspect of the system” (Auyung 1995, 47). In either sense, a definition of field makes mention of being dynamical. Dynamical systems may include gravitation, electromagnetic, or classical interactions. Interactions, however, are what allow for fields to develop. This can occur in two

ways. Fields either result from self-interacting quanta or fields interacting with other fields. In either case, these interactions provide insights to how QFT may be given a process-based interpretation.

A field may be understood as being either non-countable or countable. Understanding fields as non-countables is consistent with the first sense of *field* in which they are understood as constituents of either continuous dynamical systems or systems with infinite degrees of freedom. First, continuous dynamical systems are non-countable in a similar way as to how a process such as raining is non-countable. The system as a whole is incapable of being counted, although specific regions of the system may be countable as regions of that system. Furthermore, because the system is continuous, the system is like-parted since every spatiotemporal region of the system is a region where the system is occurring.

Something similar can be said for those systems that are described as having infinite degrees of freedom. First, systems are generally understood as being non-countable and exhibiting the like-parted relation. Furthermore, the degrees of freedom within a field are its possible fluctuations understood in terms of the values of the field at each point. A system with infinite degrees of freedom is non-countable, since “it lacks determinate identity conditions” (Cao 2004, 333).

Fields, understood as constituents of systems, are the result of either self-interacting quanta or field interactions—both of which are themselves non-countables. As Teller (1997), illustrates, quanta are inherently uncountable since they lack primitive thisness, determinate identity conditions, and the capacity for being labeled. Those self-interactions of quanta that result in the generation of a field, more specifically, are themselves similar enough to fields that we can then understand them as being both noncountable and exhibiting likepartedness. Since,

on at least one sense of *field*, we can understand fields to themselves be non-countables, we can then understand fields as resulting from the interactions of non-countables. Therefore, on the first sense of *field*, we can understand fields as being non-countable entities that are the result of interactions of non-countables. This is consistent with the first fundamental assumption of APT, which states that any non-countable entity is itself the result of interactions of non-countables.

Understanding *fields* in terms of countables is consistent with the second sense of *field* in which a field is a dynamical variable characterizing such a system or an aspect of a system. The dynamical variable is a description of a system; while the variable is itself something countable the system it is describing is not (in the sense described above). Without the system, however, the variable would not be able to characterize the system as a whole or any of its aspects. For this reason, then, we can understand fields as being consistent with the second fundamental assumption of APT, which states that any countable entity is itself the result of interactions of non-countables. Therefore, given that both senses of *field* are in some way consistent with either of the fundamental assumptions of APT, we can begin to understand how APT may be a plausible candidate for developing an ontological interpretation of QFT.

Notably, this interpretation is consistent in the shift away from a physics of individual particles as described by QFT. Instead of particular particles taken to be the fundamental building blocks of reality, processes are able to serve this role. The idea of having reality being comprised of different types of dynamic stuff (processes) is consistent with the idea that there are different types of interacting fields that allow for the development of different phenomena.

As the historical survey above illustrates, though, a process interpretation is not easily accepted. In particular, Kuhlmann (2002) addresses three worries about accepting a process interpretation of QFT. First, Kuhlmann expresses the general common concern that there is not a

“satisfactory explicit description and definition of the assumed basic processes” (Kuhlmann 2002, 103). A possible candidate for an explicit definition, he suggests, would be to understand “a process as the triple of two events and a unitary time evolution operator” (Kuhlmann 2002, 103). This suggestion has processes being grounded in events, which are themselves particulars. This is problematic for two reasons when adopting APT. First, not all processes are events, while all events can be understood in terms of processes. To then have processes dependent upon events would be to beg the question of which processes are dependent upon other processes, which does not seem to provide Kuhlmann the sort of definition for which he is asking. Second, events are particulars, which is to then have processes being dependent upon countables. The second key assumption of APT, however, suggests that any countable will itself be the result of interactions of noncountables. To have processes, which are noncountables, being dependent upon particular events, is to suggest something that is at odds with the very foundation of APT.

Second, Kuhlmann addresses the difficulties of developing a view that is in line with our explanations of everyday phenomenon:

Whereas the substance ontologist has a hard time to explain how change in time is possible, even though the things which supposedly keep their identity, the process ontologist has the opposite problem: Why do we have the strong impression that many things are more or less static if everything is composed of processes? Why does it appear that stable particles and molecules exist? One possible explanation is to assume the existence of counterprocesses that exactly balance other processes, with the overall effect of the appearance that nothing happens.

(Kuhlmann et al. 2002, 103-104)

Kuhlmann appears to be placing some significant constraints on ontological preference on an ontology's abilities to explain. This constraint is consistent with his own objection to the ontology of invariant factors, since an ontology of invariant factors is unable to contribute to understanding.<sup>80</sup> This constraint, however, is not sufficient for dismissing further pursuance of a process ontology. As Kuhlmann mentions, substance ontologists have yet to offer an adequate account of change (a point with which I agree given my discussion in earlier chapters). Although Kuhlmann adopts a trope instead of a substance ontology, he maintains that a process ontologist is unable to offer an adequate explanation of why static individuals seem to exist if everything is composed of processes. Yet, he does not commit himself to there being static individuals *in esse*, but that they are static in degrees, which is to suggest that they are not really static, but only appear so.

The issue, then, is to understand how the process ontologist can explain how things appear to be static, while they are not *really* static. First, in understanding why things should not be understood as being static is due to things coming into and out of existence when considered non-locally. In understanding things as “stable” Kuhlmann is describing a process, a process that remains stable will lead someone to believe that she is observing a static thing (including herself). But the very fact that the thing being observed and the observer are susceptible to changes is an indicator that the thing is not static at all. Kuhlmann's own recommendation that these stable configurations are themselves the result of counterprocesses may be too strong, however. If there were two processes  $P_1$  and  $P_2$ , and they are counterprocesses of each other, then they would likely stabilize each other in a way that prevents them from undergoing additional changes—unless they somehow come into contact with an additional process  $P_3$  that

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<sup>80</sup> I am making an assumption here that understanding contributes to our abilities to provide explanations.



leads them to become unstablized. Instead, it may be more parsimonious to think of the interacting processes as themselves dynamically configured in a way that leads them to be sensitive to the types of processes that are ineracting in addition to the contexts in which the interactions take place. Such configurations of interactions would allow for some objects to appear as though they are stable, while allowing the underlying interacting processes to determine the ways in which the object appears to be stable and capable of coming into and going out of existence.

Third, Kuhlmann appeals to the aesthetic preference for a somewhat sparse ontology, in which the requirement for counterprocesses may result in too dense of an ontology (Kuhlmann et al. 2002, 104). This is one of the very issues with which Seibt concerns herself in developing a monocategorical ontology, of which there are a plethora of types of processes. Both Seibt and Kuhlmann are interested in developing a monocategorical ontology, where the former is concerned with developing an ontology in terms of processes while the latter is concerned with developing an ontology in terms of tropes. Yet, both are interested in how our commonsense observations are to be understood in terms of the preferred ontology. Whereas APT makes use of types of processes, Kuhlmann's own account will have to explain why there are different types of (essential) tropes that result in our distinguishing various objects. In both cases, they will need to develop a plethora of types. For this reason, it is unclear that Kuhlmann would find this to be an objection to developing a process ontology when his own trope ontology is susceptible to the same difficulty.

Even if his argument were to go through, that process metaphysics appears to result in too dense an ontology, it is unclear why this would count as an objection. An overly sparse ontology may not be capable of aiding us in understanding reality, while an overly dense ontology (e.g.,

Meinong's "jungle") may also be incapable of aiding us in developing our philosophical accounts. In either case, it would seem that parsimony for the sake of parsimony is not itself an obviously necessary condition of theory selection. Instead, there may be other conditions that need to be met for us to prefer one ontology to another (e.g., explanatory powerful). This is the reason that the ontology of invariant factors does not appear to be preferable; it was not only because the ontology was overly dense, but it was because the ontology did not contribute to our understanding of reality that warranted its dismissal. Similarly, indicating that process metaphysics results in an overly dense ontology does not appear to be sufficient for its dismissal since there is currently a large amount of work being done to better understand how processes contribute to our understanding of scientific and everyday phenomenon. Since this work will in many ways determine if a process metaphysics is a viable option, there appears to be justification for further pursuing (or at least not dismissing) a process metaphysics.

#### **4.3.3.1 Summary**

What I have accomplished in the above sections is to suggest some of the historical and sociological reasons for not having further pursued and developed a process metaphysics within mainstream philosophy. These reasons, however, are not themselves philosophical justification for rejecting process metaphysics. Instead, the adoption of a methodological naturalism allows us to evaluate the extent to which competing ontologies fare when taking into consideration contemporary developments from within the natural sciences. One result, the non-process views do not appear to receive definitive support from any of the naturalistic developments. For this reason, assuming that metaphysics is itself a worthy task, it is then worthwhile to consider the extent to which process metaphysics is able to accommodate those same developments. The above discussion sketches some of the ways that a process metaphysics can accommodate

developments in QFT where other ontologies have failed, given the current status of the debate among philosophers of physics. Much of the discussion, however, hinges on developing an appropriate interpretation of QFT—something that is currently not available.

Since there is much debate on the appropriate ontology, it is important to clarify the conditions that need to be met for preferring one ontology to another. Among these conditions, parsimony is a condition that is often cited. The problem, however, is that parsimony is an aesthetic preference. It is strange to decide upon an ontology or theory of reality because it is taken to be more elegant when the development of an ontology is intended to provide an accurate account of reality. We should not shirk those ontologies that are at odds with our aesthetic sensibilities. Furthermore, having parsimony as a necessary condition for an ontology, for the sake of itself, also ignores our intentions behind developing an ontology for the purposes of understanding reality and explaining many of its various aspects. For these reasons, I believe that parsimony is not an appropriate guide for determining which ontologies we should pursue. Instead, I believe that we should look to the sciences and our everyday experiences and attempt to develop an ontology that accommodates both the scientific and manifest images.

Since I do not believe that the sciences are reducible to physics, one way to test an ontology is to determine how it fares in our abilities to account for phenomena in various sciences, including physics, *and* our everyday observations. For this reason, in the next section I will assess the extent to which process metaphysics is capable of accommodating developments in biology that pose problems for substance metaphysics.

#### **4.4 Development**

To review, the previous chapter assesses foundational concepts in neo-Aristotelian substance metaphysics to argue that a neo-Aristotelian ontology is inadequate for the purposes of

accommodating developments in biology and physics. The previous section of the present chapter, then, outlined how a process metaphysics may be further developed in the context of physics. This was accomplished by considering how process metaphysics is *at least* as viable of an option as other ontological interpretations of QFT. A trait of a viable metaphysical theory that attempts to offer a general account of reality, which I assume is among the aims of process metaphysics, is that it can accommodate developments in more than one science. Since the previous chapter provided insights to how a substance-based ontology is incapable of accommodating contemporary naturalistic developments, and the above section indicates that a process metaphysics is capable of accommodating some theoretical aspects of QFT, it will then be beneficial to determine if something like APT can accommodate those developments in biology that warranted not fully endorsing substance metaphysics.

#### **4.4.1 Countable but not Fundamental**

In the previous chapter, I argue that a substance metaphysics that treats living organisms as substances, which Lowe's account does, will be at odds with contemporary developments in biology. These conflicts are highlighted by aspects of the extended synthesis that indicate that an organism's development and evolution is dependent upon complex dynamical systems, including features of the organisms as well as its environment (Pigliucci and Müller 2010, 13). These multicausal evolutionary factors further blur the boundary between an organism and its environment, suggesting that living organisms do not exhibit the ontological independence, non-relationalism, and fundamentality needed for them to serve as exemplars of the category SUBSTANCE.

Yet organisms still may be thought of as being countable since they appear to have determinate identity conditions. Accounting for this countability may be one reason for thinking

that some kind of substance metaphysics is preferable for accommodating developments in biology with respect to their ontological subject matter. An organism, however, is difficult to define independently of its environment. Even though it may appear to be countable, the thing being counted is perhaps little indication of its ontological status. This at least appears to be the sort of insight that even Darwin has in suggesting that species are “arbitrary demarcation lines imposed by the human mind” (Pigliucci and Müller 2010, 7). From these points, we can summarize the argument as follows: contemporary biology is at odds with the idea of organisms as substances, and our abilities to identify and count organisms are not direct indicators of the ontological nature of what we take to be living organisms and species. Therefore, substance metaphysics and common sense do not provide direct insights to the ontological character of what we take to be living organisms and species.

The second fundamental assumption of APT, however, may provide some insights to this issue, which states that countables are the result of interactions of non-countables. Living organisms, which are countable, may be understood to be the result of interactions of non-countables—namely, processes. This, at least, appears to be the account that proponents of developmental systems theory have in mind, “The organism is not simply the object of developmental forces, but is the subject of these forces as well. Organisms as entities are one of the causes of their own development” (Lewontin 2001, 63). On this view, organisms do not evolve solely as a result of external factors (i.e., natural selection), but are able to contribute to the evolutionary and developmental processes that determine many aspects of the organism.

Furthermore, Dupré’s work on genomics provides additional insights to how we can understand the relationship between living organisms and processes. He writes,

Thus if I say that the organism is the normal unit of selection, it should be understood that the concept of organism involved is far removed from a naïve and static conception of a living individual. This organism is a process—a life cycle—rather than a thing; it may be a community of distinct kinds of organisms rather than a monogenomic individual; and it must be understood as conceptually and of course causally linked to its particular environment, or niche, which both contributes to the construction of the organism in development, and is constructed by the organism through its behavior. (Dupré 2012, 99)

The benefit of employing APT to understand living organisms is that we can explain why we are able to count living organisms even if they may not have ontologically determinate identity conditions. Furthermore, the employment of APT is consistent with contemporary developments, or can at least explain, those developments in evolutionary biology that posed direct problems to substance accounts of living organisms. The upshot of this section, in addition to the previous section, is that since APT is capable of accommodating many developments in both physics and biology, we have additional justification for further pursuing process metaphysics independently of our initial metaphysical commitments.

#### **4.5 Conclusion**

There have been three main aims of the present chapter. First, I offer a candidate explanation as to why process metaphysics has not been taken as a serious metaphysical enterprise. Second, I provide a commentary on three attempts to provide an ontological interpretation of QFT, illustrating that process metaphysics fares just as well, if not better, than other competing accounts. Third, I argue that the key assumptions of process metaphysics are able to accommodate naturalistic developments beyond physics—notably contemporary accounts of

organisms that are at odds with substance metaphysics. The result of having accomplished these aims is that there is both *prima facie* and naturalistic reasons for further pursuing process metaphysics, given that metaphysics is a worthy pursuit on its own. This is not to say, however, that the previous points have demonstrated conclusively that we should adopt a process framework, but only that those reasons appealed to for illustrating problems with the substance paradigm offer insights to how we may be able to develop a process metaphysics, given naturalistic considerations. The next chapter will specifically consider a case of how process metaphysics can accommodate an area in which substance metaphysics has apparently made some progress—*structure*.

## CHAPTER 5: STRUCTURE AS METASTABLE PROCESSES

### 5.0 Introduction

The world appears structured. We sit on chairs, set things on tables, designate seating placements, adhere (mostly) to speed limits, and count many objects. Books have beginnings, middles, and endings. Buildings can be categorized into different architectural styles. Even time appears to have an inherent structure—past, present, and future never simultaneously exist. These structures do not appear to be entirely arbitrary since they contribute to our survival; the better able we become at identifying these structures, the better we are at avoiding mishaps and making preparations for the future. Given the extent to which we make use of our understanding of these structures, they warrant philosophical consideration.

Self-described neo-Aristotelians Koslicki (2008) and Simons (1987) have made direct contributions to our understanding of the metaphysics of structure—thereby offering significant contributions to those areas that benefit from a better understanding of such structures as those found in physics, chemistry, and music. A lingering worry, resulting from following the conclusions of the previous chapters—that we should suspend judgment on the acceptance of an ontology fundamentally comprised of substances and, instead, further pursue an ontology framed in terms of processes—is that we may lose the contributions those substantive notions have made to our understanding of the structured aspects of reality. Therefore, to further motivate the pursuit of a process metaphysics, it is important to show that a process account of structure can



succeed at least as well as substance accounts. This requirement is in line with Seibt's second of three claims for what is needed to justify the adoption of process metaphysics:

*Claim 2:* Show that process-based theories perform just as well or better than substance-based theories in application to the familiar philosophical topics identified within the substance paradigm. (Seibt 2012)

Towards the establishment of the claim that a process account of structure can succeed at least as well as substance accounts, this chapter sets out to show what is problematic with neo-Aristotelian accounts of structure. I then argue that even though these accounts are in many ways consistent with our intuitive understanding of structure, a process account is able to explain these intuitions while overcoming the difficulties facing the neo-Aristotelian.

## 5.1 The Structure of Stuff

Our immediate experience of structure comes from our interactions with everyday medium-sized objects. It is in virtue of these structural similarities between past experiences  $\phi$  of objects of a structural kind  $S$  and present experiences  $\psi$  of objects that exhibit  $S$  that we are able to infer analogically between  $\phi$  and  $\psi$  that we are likely able to interact with objects that exhibit  $S$  in similar ways. For example, prior to our sitting on a chair, we take the chair to be a chair because its parts are arranged chair-wise in a similar fashion to those past objects upon which we successfully sat and understood as being chairs. Furthermore, since we distinguish one structural configuration  $S$  from other structural configurations  $T$  on the basis of how the parts are arranged (i.e., parts that are arranged chair-wise exhibit a different structural configuration from those parts that are arranged table-wise), we may be inclined to think that an account of structure will be dependent upon parts.

An account of structure that makes use of the parthood relation is in line with the neo-Aristotelian account that Simons offers, in which there are four conditions for being a structured whole or complex (Simons 1987, 354):<sup>81</sup>

1. It must consist of several parts.
2. These parts must stand to one another in certain relations.
3. These relations must connect the parts of the complex to one another.
4. The total relation of all the parts is characteristic for the kind of complex in question.

An implication from the first condition is that it precludes the possibility of mereological simples (e.g., points and monads) being structured, if such simples exist. Furthermore, the ways in which the parts are related to one another determine the type of object (or complex) that they compose.

A strength of Simons' account is that he understands the structure of objects in terms of the configuration of their intermediary parts, which seems consistent with many of our intuitions about what distinguishes one structure from another and is consistent with the neo-Aristotelian method of developing a metaphysics that is centrally informed by our commonsense observations.<sup>82</sup> Although Simons' account appears at least capable of accommodating our intuitive understanding of structure and our commonsense observations about what distinguishes one structural configuration from others, his account is not sufficient for developing a general metaphysical account of structure. In particular, an acceptable general metaphysical account

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<sup>81</sup> Simons' account is the most clearly explicated and has been used by other neo-Aristotelians as a foundation for their own accounts of structure and medium-sized objects. For example, Koslicki uses Simons' account of structure as the foundation for her own neo-Aristotelian and nondeflationary account in which she argues that material objects are structured wholes (Koslicki 2008). For this reason, my discussion will focus on aspects of Simons' account.

<sup>82</sup> Although the previous chapters argue that the employment of common sense as a metaphysical method is itself problematic, some consideration should be given to commonsense observations—if not to be consistent with them, then to at least explain them.

needs to accommodate both our commonsense observations and the underlying empirical details. Whereas Simons' account appears to meet the first of these conditions, his account fails to meet the second.

In addition to thinking that objects are fundamentally comprised of parts, the empirical data indicate that there is a physical possibility of reality being made up of stuff (Esfeld, Lazarovici, et al. Forthcoming); yet the claim that stuff exists is contentious (Steen 2012). Examples of stuff include wood, water, blood, and sand. Each of these examples, however, might be said to be comprised of more fundamental parts: wood is made up of fibers, water is made up of molecules, blood is made up of cells, and sand is made up of individual granules. To evoke a *transitive composition relation*, however, is to become ensnared in the reductionist project of attempting to identify what exists in terms of its most fundamental constituents.<sup>83</sup> Such an approach would indicate that there is no wood, but only fibers, no water, but only molecules, no blood, but only cells, and no sand, but only granules. It is arbitrary, though, to stop at any single level of reduction.<sup>84</sup>

Furthermore, appealing to a fundamental level for the purposes of analysis is of little help. As the previous chapter shows, appealing to what is taken to be a fundamental physics does not establish the fundamental ontology that we ought to accept. There are both substance- and process-based ontologies that are candidates for interpreting fundamental physics. Specifically a process-based ontology understands those fundamental constituents in terms of dynamic stuffs and a substance-based ontology understands the fundamental constituents in terms of individual particles, tropes, or substances—all of which can be understood in terms of parts that form

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<sup>83</sup> A transitive composition relation can take the following form: *if a is composed of b, and b, is composed of c, then a is composed of c, where b is sufficient for a and c is sufficient for b.*

<sup>84</sup> This is a point I argue for in Chapters 1 and 3, in which I challenge the idea of reality being stratified in terms of levels.

complexes. Given the viability of these alternative ontologies, it does not appear that a reductionist approach is able to settle the issue of the nature of the fundamental constituents that comprise any object or configuration of stuff.<sup>85</sup> Since a reductionist approach does not readily resolve the stuff vs. things dispute regarding what should be taken as members of our fundamental ontology and stopping at any “level” of inquiry appears to be either pragmatic or arbitrary, and there are both intuitive and empirical reasons for upholding the idea that stuff exists, I will continue to assume that stuff exists in at least a metaphysically thin sense.<sup>86</sup>

I acknowledge that this assumption is at odds with some intuitions since, as Lowe claims, “What we *ordinarily* call ‘stuffs’—such as butter, wood, and gold—are not homogenous stuffs in the sense [that they are capable of being infinitely divided without being divided into composite parts], because (we now believe) they are ultimately composed of atoms or molecules, which are in turn composed of proteins, neutrons, and electrons” (Lowe 1998, 72). To stop at the level of proteins, neutrons, and electrons, however, is to ignore the possibility of further carrying out the reduction to the level of fields or to take seriously the possibility that quantum mechanics provides support for the view that the world is fundamentally comprised of stuff (Esfeld, Lazarovici, et al. Forthcoming, 3).<sup>87</sup> At the moment, then, we can say that the empirical data underdetermines whether the fundamental constituents of reality are either part-like or stuff. At the very least, though, Simons’ account does not appear to capture the more general metaphysical picture since there appear to be cases of stuff being structured at some level of reduction without requiring an appeal to the parthood relation. In terms of our commonsense

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<sup>85</sup> Although the previous chapter emphasizes preference for a process interpretation, the aim was only to argue for the consideration of a process interpretation.

<sup>86</sup> Some metaphysical accounts go even further in suggesting that the reduction should never end, but, instead, it is preferable to understand things as being capable of infinitely many divisions that consist of the same stuff—in which case reality may be said to be “gunky” (Lewis 1991, 20).

<sup>87</sup> There is still some resistance to the adoption of a field interpretation of QFT (Baker 2009).

observation of those things that we label and think of as being stuff (e.g., wood, water, blood, and sand), they appear to exhibit some structure in their instances. In which sense, then, might we understand stuff as being structured?

Things are understood in structural terms given the various configurations of their individual parts. There are, however, other ways to determine that something has structure without making reference to its parts. In the case of two chairs exhibiting the same structural configuration of both having their parts arranged chair-wise, we also come to recognize two different structures by identifying distinctions between them. A chair may be said to be different from a table since they may have different heights (i.e., a chair is typically lower than a table). Furthermore, a table, in the relevant contexts, is understood as predominantly serving some functions (e.g., setting food upon) and not others (e.g., sitting upon).<sup>88</sup> Likewise, in many contexts it is generally understood that a chair is to be used in some specific ways and not others. We can say that a table and chair are structured because their parts are arranged table-wise and chair-wise, respectively. As a result of them being structured, we can distinguish them from one another. Given previous interactions, these structural configurations also allow us to make inferences about future interactions with them. For this reason, we are able to determine that an object or entity has structure without making reference to its parts insofar as we are able to distinguish that object or entity from others and make inferences about future interactions.

These conditions allow us to make similar claims about instances of stuff such as pieces of wood and puddles of water, given that we can distinguish piles of wood from puddles of water. We are also able to recognize previous instances of piles of wood and puddles of water to make inferences about our future interactions. For example, given our experiences of wood and

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<sup>88</sup> I acknowledge that these distinctions may only be conventional distinctions, but they are indicators of there existing some differences between these structural configurations resulting in conventional attitudes.

water, we would not be inclined in usual contexts to fill a swimming pool with wood or attempt to start a fire by using water. Our ability to interact with stuff in these ways indicates that there may be some way to think of stuff as being structured.

It is important to first clarify why we should dispel of the intuition that stuff is not structured. Our thinking about stuff in general is a result of our interactions with varying instances of some kind of stuff. If stuff is not structured, we would not be able to distinguish instances of stuff from other instances. There would not be anyway to identify two instances of stuff  $x$  and  $y$  in a way for us to determine that there is some other stuff  $z$  that is different from  $x$  and  $y$ . Instead, we would only be able to identify each of those instances,  $x$ ,  $y$ , and  $z$ , but would not be capable of saying that  $x$  and  $y$  are instances of the same stuff, while  $z$  is an instance of some different stuff. Since we *are* capable of making distinctions between instances of stuff, we have reasons for thinking that we are able to reliably do so because of their structural similarities and differences.

Furthermore, if stuff is not structured, we would not be able to recognize previous instances of stuff and make inferences about future interactions with them. In particular, as the previous paragraph states, we would not be able to identify two instances of stuff  $x$  and  $y$  as being instances of the same kind of stuff. Without being able to identify similar instances of similar kinds of stuff, we would be prevented from making reliable claims about future cases involving instances of those same kinds of stuff. We would not be able to identify two instances of stuff  $x$  and  $y$  as having the same attributes that would then warrant similar assessments of  $x$  and  $y$ . For example, two instances of water would not be recognized as both having the capability of being drunk without recognizing they are instances of the same kind and that the successful interaction with one warrants considering interacting with the other in a similar way. In short,

making reliable claims about future cases requires identifying instances of the same kind of stuff. Since we do recognize similar instances of similar kind of stuff and successfully make inferences about our interactions (e.g., drinking water for hydration), we have reasons to think that there are structural similarities between the instances of the same kind of stuff that allows for these successful interactions.

As the two previous paragraphs show, since we are able to distinguish instances of stuff and appeal to previous instances to make inferences about our future interactions with instances of the same (or similar) kinds of stuff, due either to their similarities or differences, we have reasons to believe that stuff, more generally, is structured. It is still unclear, though, in which ways we should understand stuff as being structured.

The most notable feature of stuff that allows us to understand its structure is that any instance of stuff maintains some structural configuration. First, any instance of stuff has both spatial and temporal boundaries. For example, a piece of wood does not occupy all of space and time. Second, any instance of stuff has modal and causal structures that contribute to the distinguishing of one kind of stuff from others, while also allowing us to identify those instances of stuff that are temporally and spatially bound while possessing the same modal and causal structures as likely instances of the same stuff.<sup>89</sup> For example, a piece of wood *can* be used as fuel for fire, whereas a puddle of water *can* be used to extinguish or prevent a fire. By successfully identifying these structural elements of these instances we are then able to reliably employ stuff in the world—we build fires using wood and fill swimming pools with water.

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<sup>89</sup> Chapter 7 will discuss how laws can contribute to our understanding of modal and causal structures.

Since we come to understand stuff through their individual instances, and we employ structural similarities and distinctions to reliably use stuff in the world, we have good reasons for maintaining that stuff is structured.

Even though stuff may be structured, it lacks parts in the same way that things have parts. As Lowe claims, the parts of a thing exhibit determinate identity and countability conditions (Lowe 1998, 74). For example, a wooden chair may be made up of a back, seat, and four legs. In answering the question, “How many parts make up the chair?” we can respond “six.” We can also identify each leg of the chair as being a leg of the chair and not a seat.

Since we can divide and draw out some aspect of stuff, we might be inclined to think that stuff has parts in the same way as things. This, however, is not the case. Assuming that something like water is homogenous, we can divide the water in a pitcher by pouring the water into six glasses. The water maintains determinate identity conditions since we can identify the water in the six glasses as being the same as the water that was in the pitcher. Yet there are not determinate countability conditions for the parts of water in the same way that there are for the parts of the chair. In the case of the chair, we are able to identify six distinct parts that make up the chair. In the case of the water in the pitcher, we could just as well have chosen to pour the water into twelve glasses. Although there would be less water in each of the twelve glasses than if we were to pour the water into the six glasses, presuming we are pouring equal portions, it is not clear that either number of glasses is indicative of the number of parts. Furthermore, by adding more water to the initial amount in the pitcher we would not be adding more parts, but only more quantity. This thought clarifies why we find it appropriate with something like water to ask “How much such-and-such?” instead of “How many such-and-such?”



Instead of thinking that stuff has parts in the same way as things, it is preferable to think of those aspects that we draw away from stuff as *pieces* of stuff (Lowe 1998, 74). These pieces maintain both determinate identity and countability conditions, but should not be thought of as parts. In the case of water, we can divide it into multiple pieces by pouring it into different containers, but in each case it is the amount of water that is being divided without dividing it into its smaller component parts in the same way that we do with the chair when we divide it. This observation is perhaps what we have in mind when we say that a chair has become “broken” since its parts have become removed or rearranged in such a way that we see the parts *qua* parts of a chair. We cannot, in the same fashion, break water to reveal its intermediary parts that make up the more general complex, assuming that we are not thinking of water as a mixture (Seibt 2003, 43)

Despite our inability to count the individual pieces as being parts of stuff, we are still able to identify and distinguish them; the ability to do so indicates that we should maintain that stuff is structured. For example, societal roles such as being a doctor allow us to identify the structure of stuff without being able to count its intermediary parts.<sup>90</sup> We may be able to identify the parts of the individual human being who takes on the role of being a physician, but there is no set of parts that make up a physician—even though we can recognize the physician as such. We are capable of carrying out similar lines of inquiry for our understanding of general life processes, organisms, and fields.<sup>91</sup> All of which, even though we cannot identify their strict countability conditions, we still maintain exist (although it may not be clear yet in which sense they do exist).

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<sup>90</sup> This is a modification of Lowe’s own example of the *police officer* (Lowe 1998).

<sup>91</sup> The next section will discuss how we are able to do so.

Given the above considerations that stuff is structured and does not necessarily possess parts, in at least the same way that things have parts, we can infer that being structured does not require having parts. The implication is that Simons' first condition for structure is not a necessary condition. Although Simons' account provides a good indicator for what allows us to believe that medium-sized objects are structured, his account is not generalizable to objects that are described using mass nouns or more fundamental constituents. For this reason, we should seek out another metaphysical account of structure—but one that, more specifically, does not rely upon parts. In the next section, I will argue that a process framework can offer such an account.

## 5.2 Stable Processes

The process framework that I am assuming here is an axiomatic process theory of the form developed and defended by Seibt (2012). To review, free processes have six characteristics:

1. Concrete or spatio-temporally occurrent
2. Individual
3. Dynamic stuffs
4. Non-particulars or multiply occurrent
5. Not fully determinate
6. Not directed developments (events) but dynamically homonomous<sup>92</sup>

In adopting a monocategorical ontology, in which all that exists is understood in terms of free processes, some account of structure will need to be given within this process framework. And since processes lack the transitive part relation found in substance ontologies, this account of

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<sup>92</sup> More will be said in a moment about how events are a type of process.

structure does not depend upon parts in the same way as things that resulted in the difficulties facing Simons' account. The previous section offers some insight on how this might be accomplished by arguing that stuffs can be understood in structural terms without possessing parts. By understanding processes as dynamic stuffs, the ways in which we understand stuffs as being structured can provide insight to how processes are also structured. Notably, our abilities to distinguish between different types of stuffs and make inferences about our interactions with stuff provide evidence for maintaining that stuff is structured. Since processes are dynamic stuffs, we have reason to believe that processes are also structured if we are able to distinguish between different types of processes and make inferences about our interactions with them.<sup>93</sup>

Towards the aim of demonstrating how we can distinguish between different types of processes, Seibt has developed a typology of free processes (Seibt 2003, 41-43).

*Type 1:* Temporally maximally self-contained and spatially unmarked (e.g., running).

*Type 2:* Temporally minimally self-contained while their spatial self-containment is unmarked (e.g., developments, events).

*Type 3:* Spatially minimally self-contained and temporally maximally self-contained (e.g., things and discrete matter that 'endure').

*Type 4:* Spatially and temporally self-contained (e.g., oscillatory sequences and heaps / collections).

*Type 5:* Spatially and temporally maximally self-contained (e.g., masses and stuffs proper).

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<sup>93</sup> For purposes of the present discussion I am assuming that the ability to distinguish them is sufficient for thinking of them as being structured and it is *because* we are able to distinguish them that we are able to make inferences about them.

Earlier in this chapter I stated that if an object or entity is not structured then we would not be able to distinguish instances of stuff from other instances. Something similar can be said for processes; our ability to distinguish instances of processes from others indicates that processes are structured. The above typology helps support this claim.

First, we are able to identify two processes as being of the same type of process. For example, two instances of running are understandably of the same type of process if we understand running as being an instance of a type of process. Using the typology above, running is an instance of the first type of process since any instance of running is temporally maximally self-contained. The *completeness condition* for activities states, “from ‘*N* is *V*-ing’ we can infer that ‘*N* has *V*-ed’ [where ‘*N*’ is some noun and ‘*V*’ is some verb]” (Seibt 2003, 26). Therefore, any time at which *S* is running is also a time at which *S* ran. Furthermore, any location at which *S* runs is an instance of running, but running involves different locations at different times. So, although running is spatially self-contained it is not maximally self-contained.<sup>94</sup> Since any instance of running is temporally maximally self-contained and spatially self-contained, and being temporally maximally self-contained is both a necessary and sufficient condition for being an instance of a Type 1 process, any instance of running will be an instance of a Type 1 process. Therefore, we are able to identify two distinct instances of running as being instances of the same type of process.

Something similar can be said for two different activities. In the case of swimming, any instance of swimming is temporally maximally self-contained since any time at which *S* is swimming is a time at which *S* swam. Swimming, like running, is also spatially self-contained

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<sup>94</sup> In stating that Type 1 processes are spatially unmarked indicates that there are Type 1 processes that are spatially maximally self-contained (e.g., falling), self-contained (e.g., raining), and minimally self-contained (e.g., a couple’s instance of pair-dancing) (Seibt 2003, 41).

since it is contained to some spatial region (e.g., a swimming pool) but occurs over a duration of time involving a different location at each time. Similar to running, since any instance of swimming will be both temporally maximally self-contained and spatially self-contained, it will be of the same type of process as running. Therefore, since running is an example of a Type 1 process, swimming is also an example of a Type 1 process.

Second, since we are able to identify two different processes as being instances of the same type, we are now able to distinguish different types of processes. What allows for both running and swimming to be instances of Type 1 processes is that they are both temporally maximally self-contained, since being temporally maximally self-contained is both a necessary and sufficient condition for being an instance of a Type 1 process. For this reason, if some other process is not temporally maximally self-contained, then that process is an instance of some other type of process.<sup>95</sup>

The event of winning a race is an example of a process that is not temporally maximally self-contained. For *S* to win a race, she must start no sooner than the allowed time to start the race; complete the race before all of the other participants; and adhere to the racing guidelines. Although each of these conditions are necessary for *S* to win a race, none of them are individually sufficient—that is, none of the contributive parts to the winning of a race are themselves instances of winning a race. Since each of these components for winning a race occur at different times, there is no single time at which winning a race occurs even though the finishing of a race occurs at a specific time. Therefore, winning a race is minimally temporally self-contained.

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<sup>95</sup> The process framework within which I am working does not allow for the possibility of something existing without being an instance of a type of process.

Given that winning a race is not maximally self-contained, we can distinguish winning a race as being a different type of process from activities such as running and swimming (even though running and swimming may be required for winning some types of races). Using the typology above, since being temporally minimally self-contained is both necessary and sufficient for being an instance of a Type 2 process, and the event of winning a race is itself temporally minimally self-contained, it follows that the event of winning a race is an instance of a Type 2 process.<sup>96</sup>

The ability to distinguish among different types of processes provides reason for believing that processes are structured. In understanding what allows these distinctions to be made, we can then understand what it means for something to be structured.

I maintain that processes are structured insofar as they exhibit stability for some duration.<sup>97</sup> In other words, to be structured is to be a stable process. It is unclear, though, what it means for a process to be stable, since there are at least four potentially applicable accounts of stability: an intuitive account, Liapunov stability, a lowest entropy account, and metastability. I will consider each of these accounts to argue that the first three are problematic, while endorsing the fourth. In particular, the fourth account allows us to distinguish between different types of processes, which, in turn, allows us to explain what makes processes structured.

First, an intuitive account of stability can be stated as follows: a process is stable if it maintains some approximate degree of similitude at two different connected times. This intuitive account is used by philosophers of science, such as French (2014), who maintain that what is real

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<sup>96</sup> In the previous chapter, I discuss how Salmon's attempt to work within a process framework is problematic because his distinction between a process and an event is vague. The account discussed here indicates how we may overcome this difficulty by thinking of events as a type of process.

<sup>97</sup> The amount of time needed for a process to be stable depends upon a resolution to the debate of whether time is dense or discrete.

is “what was invariant under symmetry groups (a formal stability) or invariant perturbations (dynamical stability). Paradigm cases included 2-body solar system dynamics, engineering lever and circuit equations, [and] equilibrium thermodynamics of gases” (Hooker 2011, 11). This clarifies why activities (e.g., running and swimming) and events (e.g., winning a race) may be thought of as being structured. Specifically, an activity appears to be stable when there are similarities in the aspects involved in the activity over time. For example, the activity of running involves particular movements being sustained; whereas we would not think of a person *S* being involved in a single instance of running if *S* periodically interrupts her movements with instances of sitting, walking, or jumping. Instead, there would be multiple instances of running, each framed by other activities that themselves end once *S* either re-engages in running or engages in some other activity.

So far this explanation only accounts for instances of Type 1 processes. It can also accommodate the stable aspects of an event such as winning a race. Since winning a race involves starting no sooner than any of the other participants; finishing the race before any other participant; and adhering to the race guidelines, these aspects must maintain some degree of similitude in that they each are necessary conditions for winning a race. Furthermore, these aspects cannot all start at the same time since starting and finishing a race cannot be simultaneous.<sup>98</sup> They also maintain their degree of similitude during at least two different connected times, which would be the duration of the race. We can then understand these aspects and their stable configuration as being the structure of the event of winning a race since they must exhibit a particular order (i.e., starting, adhering, and finishing), while also exhibiting spatial and temporal boundaries (e.g., the race is spatially and temporally bound by its starting

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<sup>98</sup> If someone wishes to make the case that there is some inertial frame of reference in which the starting and the finishing of the race *are* simultaneous, then that would be a frame of reference in which no race occurs.

and finishing points and the course itself). Therefore, by identifying those stable aspects of winning a race we are then able to understand how an event, an instance of a Type 2 process, is structured.

Unfortunately, things are not so simple. The key condition of what I am calling the intuitive account of stability is that the aspects involved in a process exhibit *some approximate degree of similitude*. This condition runs the risk of making the concept of stability, and thus structure, vague, in which case every process might be thought of as being stable or structured. This result may not be obviously problematic when working within the confines of a monocategorical ontology that interprets everything under a process interpretation. But in allowing a process to be stable if it exhibits some approximate degree of similitude is to allow for the possibility that every process is structured since every (physical) process exists in space and time.<sup>99</sup> This possibility renders the idea of structure meaningless since it would strip our explanation of the appropriate contrast class (i.e., being unstructured) for explaining what makes something structured. Therefore, the intuitive account of stability is problematic.

Since the main problem with the intuitive account of stability is that it may result in vague attributions of stability, it may be useful to consider instances of Type 3 processes. Processes of this kind are in-line with what we may think of as ordinary objects (e.g., chairs), and, for this reason, may appear to be non-borderline cases of processes. Instead, they appear to have clear identity and countability conditions as a result of their ability to *endure* (Seibt 2003, 42). This endurance is a result of their being temporally maximally self-contained, since at any moment every part of the object is wholly present.

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<sup>99</sup> I am not considering the possibility of processes as being abstract objects in this dissertation.



Type 3 processes maintain some aspects of the intuitive account of stability since they exhibit a high degree of similitude over time. In this way, we can think of an object as remaining stable in its abilities to maintain its configuration over time. For example, a chair maintains its shape over time since each of its components remains close to one another in a sufficient way for it to be identified as a chair. In some sense, we can think of each component as attracting each other in a way that allows them to maintain that configuration over time. This is in line with *Liapunov stability*, which suggests that something is stable insofar as the trajectory of each component remains sufficiently close to its origin for all time (Strogatz 2015, 130). By thinking of stability as Liapunov stability, we can at least avoid the difficulties of the intuitive account of stability by not resulting in the same sort of vagueness.<sup>100</sup> Instead of relying upon any one part to maintain a stable configuration with others, it is those that have a point of origin that maintain their trajectories that we are concerned with. So, in the case of the race, there will be particular components of the race that we will be interested in that contribute to S's winning—namely, those that are essentially or necessarily, and at least not accidentally, involved in the winning.<sup>101</sup>

Whereas Liapunov stability is able to overcome the vagueness issue that poses problems for the intuitive account of stability, it is still not an adequate account since it does not accommodate physical processes as they occur in everyday experiences. Instances of Type 3 processes are understood in terms of things and “discrete expanses of matter” (Seibt 42, 2003). As discussed in Chapter 2, the puzzle of change indicates that objects are not to be treated as fundamental substances. Instead, they are better understood as ontologically dependent upon some other aspect that allows them to come into, sustain, and go out of existence. The observation of objects coming into and out of existence indicates that there is no physical process

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<sup>100</sup> I acknowledge that ‘sufficiency’ results in its own problems of vagueness, which I will not discuss.

<sup>101</sup> I am not making any dispositional or modal commitments here.

that is able to maintain some configuration for *all* time in the way described by Liapunov stability. Instead, Liapunov stability, at best, appears to be a mathematical idealization of dynamic systems. This in itself is not problematic, but, for the purposes of understanding how physical processes are able to exhibit stability, it does not explain how we observe objects in the world. It is not sufficient for a metaphysical account to only accommodate ideal empirical data, but it must also explain our commonsense observations.

Instead of adopting either an intuitive or mathematical formulation of stability, it may be preferable to explain stable processes in terms of physical systems. On this view a physical system is measured in terms of its *energy*—that is the ability for a system to work. One of the ways to understand the abilities for a system to work is the extent to which it is disordered; the disorder of a system is measured in terms of its *entropy*. By understanding the entropy of a system, we can understand the way in which a system is stable. In particular, an unstable system is a system that has a high level of entropy that is more susceptible to dynamic fluctuations, while a stable system will have a low level of entropy that prevents it from being susceptible to as many fluctuations.

This account of stability can accommodate instances of Type 1, Type 2, and Type 3 processes. First, if we understand activities as systems, then the sustainment of an activity is also the sustainment of a system. Second, by understanding how an activity is undertaken, we can then understand the dynamics of the relevant system. In the case of *S* undertaking the activity of running, *S* contributes to the maintaining of a system enacting a particular process in a way that prevents it from being susceptible to changes. The point at which the activity can no longer be sustained, which may result from insufficient inputs to the system, is when it becomes more susceptible to local factors external to the system—thus resulting in the cessation of the activity.

Second, events may also be understood in terms of systems in which the dynamics of that system shape how the relevant components may participate in the system. In the event of winning a race, the participants and the course must maintain the appropriate configuration in relation to one another such that an event like winning can occur. In particular, it is because of the individuals involved in the race being comprised of local micro systems that maintain low degrees of entropy that they are able to participate in the event of winning a race. This leads to the third point that this account of stability can accommodate instances of Type 3 processes by understanding those things that make up events as themselves as being processes that remain stable (in terms of their entropy levels) such that they are then able to make up events or be involved in activities.

It is not enough, however, to think of stability in terms of lowest levels of entropy, since there are systems that we would understand as being stable that are not involved in maintaining any one level of entropy. For example, running, although a sustained activity, may also be understood in terms of an instance of Type 4 processes, in which running is thought of as being an oscillatory sequence involving the repetitive movement of an individual organism's legs (Seibt 2003, 42). The individual organism may appear to exhibit some stable configuration despite its abilities to move from the activity of walking to the state of running, in which one may be understood as being a different magnitude of disorder from the other (at least in terms of the degree to which one activity is more susceptible to external influences). Similar, the melting and freezing of a collection of water may be seen as moving from a more entropic to less entropic state. Yet that collection of water may be said to be stable in a more general sense of being recognized as being stable. For these reasons, then, it appears that thinking of stability only

in terms of entropy is not able to accommodate all types of processes—even those that we would still think of as being capable of being stable.

Even though measurement of entropy is not sufficient for thinking of the general sense of stability, I still believe its ability to accommodate the first three types of processes is an indicator of how we should think about stability. In particular, by discussing the organization of a system provides some insight to what allows it to be stable. What appears to be problematic about the case of the entropy conception of stability is that systems undergo change and very few systems can be said to ever be at their lowest point of entropy. This is due in large part to the fact that no system exists entirely in isolation from some other system. This is an insight held by Lorentz, who observed that the context in which some system occurs could itself determine the extent and manner in which the system remains stable or fluctuates (Lorentz 1993, 22). It would seem, then, that some attention should be given to both the organization of the system and the context in which the system occurs to develop an appropriate account of structure.

This is something, I believe, that the metastable account can accommodate since it not only addresses the context and organization of the system itself, but also the ways in which a system is capable of developing and adapting. In particular,

Metastability has been used by different research communities for different purposes, but we use the term to identify systems for which numerous patterns of activity co-exist as latent potentials. The probability of any particular pattern organizing into existence is a function of variables both internal and external to the system. A system becomes more flexible, and more metastable, as its capacity to concurrently hold many distinct latent patterns increases. This capacity is essential to the adaptability of cognitive systems, and biological systems in

general, because it allows them to respond to changing conditions, i.e., by organizing different patterns of activity. From this perspective, systems become more adaptive as the probability distribution over potential patterns is shaped to maximize their expected fitness. (Kello, et al. 2008, 1218)

I believe that this view of metastability is more promising than the previous accounts of stability since it is able to accommodate instances of each type of process. In the first case of an activity of running, there will always be some other process or configuration of processes engaged in the activity. Yet there are different ways in which running can occur and begins and ends. So although thinking about running as being stable in the entropic sense accommodates the activity of running as being a stable form of organization, the metastable idea more appropriately describes the activity by acknowledging the subject involved in the activity as well as the environmental processes that may contribute to the manner and duration in which the subject is able to perform the activity.

Furthermore, an event is better explained in terms of the metastable account since it takes into consideration the multiple systems that are engaged in the appropriate ways for the race to take place. Whereas the entropic account resulted in the counterintuitive outcome of thinking of each of the microsystems remaining at its lowest energy level for the sustainment of the winning of the race, the metastable account is able to accommodate each of the systems since it understands systems as being capable of interacting with one another. This is in line with Kello et al. who write, “This pervasiveness comes from the fact that critical phenomena result from the way system components interact with each other, not any particular system component or process. Moreover, the components can be cells, brain areas, body parts, or entire organisms, because metastability is hypothesized to hold across scales of analysis” (Kello et al. 2008, 1220).

Not only does this view account allow the other participants, as their own metastable processes, to be directly involved in the winning of the race, but also allows the possibility of the local environment to be a system itself that contributes to the event of winning a race.

The way in which a metastable account can explain the environmental factors as playing possible causal roles in bringing about an event such as winning a race is due to the metastable account being capable of explaining instances of Type 3 processes, which are ordinarily understood as being objects and things. The problems that arose with the neo-Aristotelian and intuitive accounts of stability is that they face difficulties of accounting for change and vagueness, respectively. The metastable account, however, can accommodate these issues by identifying change as being a result of a system responding to various environmental and temporal factors, which are themselves understood in terms of metastable processes.

Furthermore, the metastable account is able to overcome the problem of vagueness by allowing for medium-sized objects to be a description of a particular phase state of the process that allows it to be identified as such. Once a process no longer exemplifies that state, thought, the chair as such may not exist in the new state, but the process itself may not cease to exist. Instead, it may be due to the multiple interacting processes that were in the metastable state of being a chair that they become reconfigured in a way that does not allow them to appropriately interact in a way that results in the configuration of a chair, but, perhaps, instead form a configuration that would be recognized as a splintered pile of wood.

Furthermore, the entropic account is most troublesome when considering oscillatory sequences since it attempts to describe phenomenon in terms of the phase state of a single system. The metastable account, however, can accommodate oscillatory sequences by identifying those processes that interact with one another, resulting in the specific phenomenon.

In the case of running, the activity can be understood as the repetitive alteration of leg movement, where each leg can itself be understood as requiring multiple systems engaging each other to result in the pattern of running. Furthermore, the melting and refreezing of water is itself due to changes in the local environment that have direct impacts on the component processes that are involved in the formation of water.

Last, the metastable account is also capable of accommodating instances of Type 5 processes, which are spatially and temporally maximally self-contained—any instance of stuff is both a temporal and spatial location at which the stuff is wholly present. In the case of a small puddle of water, it impacts the local area by either cooling the air or moistening the surface upon which it is situated. Both the air temperature and type of surface, however, can contribute to the way that the water continues to exist, which, in turn, can alter the temperature and water of the surface. While the air, water, and surface may each on their own be understood as a metastable process, given the above discussion of metastable instances of Type 3 processes, they are also engaged in a metastable process that allows for the sustainment of the water.

This observation is consistent with the idea that metastable processes pervade all levels of analysis, but also allows us to understand how a process view can accommodate our common sense understanding of stuff, while also maintaining consistency with the contemporary empirical data, which is something that Simons' own account was unable to accomplish. In particular, by recognizing that our common sense observations of things and stuff are instantiations of some metastable phase of a more general process, we can then begin understanding which underlying processes are themselves in some other metastable state, including those that result in our perception, that are described by some contemporary science.

By understanding processes as dynamic stuffs, and by using the typology above, we are able to recognize how we might make ontological distinctions between the instances of physical processes. The benefit, though, of thinking of these instances as being metastable processes, and it is because of their varying metastable phases that allow us to make distinctions, is that we can overcome the difficulties facing some more traditional approaches. The upshot of doing so is that we are able to not only show how a monocategorical process framework fares as well as mainstream substance views, but that, in many ways, it fares better. Furthermore, since this process account is not dependent upon parts, which is what prevented Simons' account from being expanded to metaphysical general accounts, the process account of structure is a viable candidate for being extended to other areas.

### **5.3 Conclusion**

The previous discussion assumes a process framework for understanding how we can conceive of ordinarily experienced and observed phenomena as each being an instance of one of the types of processes. This approach, however, may appear to be question-begging since I have only found a way to appropriate a process framework for the purposes of arguing for process metaphysics. It is important to point out, though, that I have also given consideration to the mainstream substance views and have shown that by assuming a process framework we can overcome many of the difficulties facing the mainstream accounts of substance and structure. In showing that the process framework can not only overcome these difficulties, but also explains many other phenomenon at various levels of analysis, I have shown that the process framework fares better than those competing views.



## CHAPTER 6: A PROCESS FRAMEWORK FOR ONTIC STRUCTURAL REALISM

### 6.0 Introduction

In the previous chapter I argued that a process metaphysician can provide an account of *structure* by understanding structures in terms of metastable processes. Furthermore, as earlier chapters showed, the adoption of a process framework follows from naturalistic considerations that result in the suspending of judgment on the status of substance metaphysics. These developments are consistent with the ontic structural realists' own enterprises to develop a naturalized metaphysics. Furthermore, since a process framework is itself a monocategorical ontology, it requires that anything that exists to be understood in terms of processes. But since for something to be recognized as existing it must exhibit some stable configuration, it exhibits structure. For this reason, a process-based account of structure is consistent with the ontic structural realist's slogan "all that exists is structure." The aim of this chapter is to show that, given these commonalities between process metaphysics and ontic structural realism, an ontic structural realist *can* adopt a process framework.<sup>102</sup> I will specifically discuss how current attempts by some ontic structural realists are too limiting in their attempts to constrain metaphysics to physics, but that these limitations can be overcome by adopting a process framework.

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<sup>102</sup> The next chapter will discuss how an ontic structural realist *should* adopt a process framework in developing an account of laws of nature.

## 6.1 Ontic Structural Realism and Naturalized Metaphysics<sup>103</sup>

Philosophers of science have typically come in two kinds: scientific realists who endorse the thesis that science provides an accurate description of the unobservable world, and anti-realists who maintain that science aids our interests, but hold that there is no good reason to think that any science's description of the world is true. Both camps, however, appear to face intractable problems. Scientific realism faces the "pessimistic meta-induction": since many of the entities appealed to in previous scientific theories have been rejected, it seems irrational to hold that current science correctly describes a theory-independent world. Although anti-realists adopt the lesson of the pessimistic meta-induction, they are unable to provide an adequate explanation for the fact that science has enjoyed considerable experimental success. There is a third position, structural realism, which attempts to overcome these challenges.

Worrall's (1989) essay serves as the catalyst for the structural realist movement, although elements of the theory can be found in Poincaré (2001) and even Kant (1998). Worrall acknowledges that the pessimistic meta-induction poses serious obstacles for the scientific realist. Yet he does not want to endorse either anti-realism or instrumentalism, since it would have to be something like a "miracle" for science to be as successful as it has been if either of those options were true. Instead of understanding the task of science as involving the development of descriptions of unobservable entities, the structural realist understands science as aiming to provide an accurate description of the world's structure.

Although the change in theories requires a shift in our understanding of what kinds of entities exist (e.g., the aether), the mathematical structure of scientific theories remains mostly

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<sup>103</sup> The majority of this section in its current form is currently underneath review with *Lato Sensu: Revue de la Société de Philosophie des Sciences* (submitted February 2<sup>nd</sup>, 2015).

intact. In cases such as these, Poincaré (2001), Russell (1927), Worrall (1989), Votsis (2005), Demopoulos and Friedman (1985), and Morganti (2004) adopt the epistemic attitude that the most we can *know* about the world is its structure, despite there being something over and beyond that structure. This view is in contrast to the ontic structural realist position held by French (2014) and Ladyman and Ross (2007), which states that the only things that *exist* are structures. This section focuses on the ontic structural realist position that Ladyman and Ross advocate and their endorsement of *radically naturalized metaphysics*. In particular, I aim to show how ontic structural realists might benefit from non-radically naturalized forms of metaphysics.<sup>104</sup>

The discussion unfolds as follows: section one provides a brief discussion of the formulation of radically naturalized metaphysics defended by Ladyman and Ross, which has as its tasks the unification of the sciences and the modeling of the objective structure of reality; section two outlines two key regulative principles for radically naturalized metaphysics: the *principle of naturalistic closure* and *primacy of physics constraint*; section three takes into consideration some implications of these regulative principles for the purposes of unifying the sciences and modeling the objective structure of reality; I then conclude with a discussion of why ontic structural realists should be more friendly towards the adoption of a non-radically naturalized forms of metaphysics—especially process metaphysics.

### 6.1.1. Radically Naturalized Metaphysics

At first glance, it might seem that ontic structural realists would be entirely hostile towards metaphysics, since there are many commonalities between logical positivism and ontic

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<sup>104</sup> French (2014) and McKenzie (2014) appear to be more sympathetic to non-radically naturalized forms of metaphysics. In showing that the radically naturalized form of metaphysics that Ladyman and Ross defend benefits from non-radical forms, we can make room for discussions determining the best form of naturalized metaphysics.

structural realism. The statements “The criteria of adequacy for metaphysical systems have clearly come apart from anything to do with the truth. Rather they are internal and peculiar to philosophy, they are semi-aesthetic, and they have more in common with the virtues of story-writing than with science” (Ladyman and Ross 2007, 13) and “We think that [Neo-Scholastic metaphysicians] are indeed doing nothing but revealing properties of themselves and don’t usually realize it” are reminiscent of Ayer’s remark that “it is fashionable to speak of the metaphysician as a misplaced poet. As his statements have no literal meaning, they are not subject to any criteria of truth or falsehood: but they may still serve to express, or arouse, emotion, and thus be subject to ethical or aesthetic standards” (Ayer 1946, 44).

These similarities illustrate some of the motivation behind the ontic structural realists’ hostility towards much of contemporary analytic metaphysics, but many positivists would be resistant to the ontic structural realist’s slogan that *all that exists is structure*. The claim does not meet the requirements of the positivistic *criterion of meaningfulness*, which holds that only statements that are empirically verifiable or tautologies can be meaningful.<sup>105</sup> So even though ontic structural realists in many ways revive the spirit of positivism, they are engaged in a very different project from the positivists’ since the positivists were hostile to the attempt to construct ultimate theories about reality.

There have been many attempts at offering a naturalized metaphysics. As Macarthur (2010, 124) indicates, naturalism has been defended by the likes of Armstrong (1978), Devitt (1984), Dretske (1995), and Papineau (1993). Although generally understood as endorsing a radically naturalized metaphysics, Ladyman and Ross do not clearly distinguish *radical*

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<sup>105</sup> This is the strong formulation of the criterion of meaningfulness (Ayer 1934). The ontic structural realist’s slogan also fails to meet the demands of the weaker formulation, which only requires that the claim in question be *capable* of verification (Schlick 1936).

naturalistic metaphysics from other forms of naturalistic metaphysics, since they take their construal to be the only correct formulation. In Ladyman and Ross's formulation, radically naturalized metaphysics has the task of unifying the sciences and is the only kind of metaphysics suited to model the objective structure of reality. These tasks are further elucidated by two regulative principles: the *primacy of physics constraint* and the *principle of naturalistic closure*.

### 6.1.2 Regulative Principles

First, the *primacy of physics constraint* states that any metaphysics or special science that is at odds with our best contemporary physics "should automatically be rejected for that reason alone. Fundamental physical hypotheses are not symmetrically hostage to the conclusions of the special sciences" (Ladyman and Ross 2007, 44). The primacy of physics constraint serves as a constraint on how radically naturalized metaphysics should unify the sciences and model the objective structure of reality by appealing to our best contemporary physics. Furthermore, the primacy of physics constraint supports ontic structural realism in its claim that all that exists is structure. By adopting our best contemporary physics, which Ladyman and Ross argue is quantum field theory, we can then begin to accept an ontology not of things but of structures.<sup>106</sup>

Second, the primacy of physics constraint functions in tandem with the *principle of naturalistic closure*, which states that

Any new metaphysical claim that is to be taken seriously at time  $t$  should be motivated by, and only by, the service it would perform, if true, in showing how two or more specific scientific hypotheses, at least one of which is drawn from fundamental physics, jointly explain more than the sum of what is explained by

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<sup>106</sup> The appeal to QFT undermines the very project of constructing an ontology since 'ontology', from 'ton ontos' refers specifically to things, but endorses a metaphysics that does not include an ontology. French (1998) makes a similar point.

the two hypotheses taken separately, where this is interpreted by reference to the following terminological stipulations. (Ladyman and Ross 2007, 37)

The initial formulation of the principle of naturalistic closure indicates the conditions that must be satisfied if we are to endorse a metaphysical claim. As the above quote indicates, there are additional stipulations that clarify which hypotheses provide support for the serious consideration of some metaphysical claims. In the third stipulation we specifically see how the principle of naturalistic closure supports radically naturalized metaphysics.

Stipulation: An ‘objective research project’ has the primary purpose of establishing objective facts about nature that would, if accepted on the basis of the project, be expected to continue to be accepted by inquirers aiming to maximize their stock of true beliefs, notwithstanding shifts in the inquirers’ practical, commercial, or ideological preferences. (Ladyman and Ross 2007, 37)

In particular, what is taken to be an objective research project will determine what the task of the metaphysician will be—insofar as her task is to model the objective structure of reality. To do so, then, will require the metaphysician to look to those projects that are understood as being objective research projects.

Since the aim of the principle of naturalistic closure is to determine which metaphysical claims concern the nature of the world as described by science, it is important to understand what counts as a scientific hypothesis. This is clarified by the first stipulation, in which a ‘scientific hypothesis’ is understood as being “an hypothesis that is taken seriously by institutionally bona fide science at *t*” (Ladyman and Ross 2007, 37). Since those metaphysical claims would have been acquired through scientific processes, which Ladyman and Ross claim are the most reliable “epistemic filters,” the resulting “stock of true beliefs” will itself be unified (Ladyman and Ross

2007, 37). Since those beliefs are the result of scientific processes, the unification of those beliefs will offer insight as to how we can unify the sciences.<sup>107</sup>

The second stipulation of the principle of naturalistic closure states,  
Stipulation: A ‘specific scientific hypothesis’ is one that has been directly investigated and confirmed by institutionally *bona fide* scientific activity prior to  $t$  or is one that might be investigated at or after  $t$ , in the absence of constraints resulting from engineering, physiological, or economic restrictions or their combination, as the primary object of attempted verification, falsification, or quantitative refinement, where this activity is part of an objective research project fundable by a *bona fide* scientific research funding body. (Ladyman and Ross 2007, 37-8)

This stipulation, however, raises the question of how the principle of naturalistic closure is to go about restricting metaphysics, since, although the principle requires that a metaphysical claim  $M$  at  $t$  be of service to some scientific hypothesis  $H$ , it does not state *when*  $M$  must be of service to  $H$ . For this reason, there is the lingering possibility that  $M$  at  $t$  can be of service to some  $H$  at  $t_{+n}$ . To make this more precise: the principle of naturalistic closure states that for a metaphysical claim to be taken seriously when it is proposed at  $t$  it should be motivated by “and only by” the role it would serve in making two or more scientific hypotheses more explanatorily powerful. Yet the scientific hypotheses that would justify the employment of a metaphysical claim do not need to be currently investigated or confirmed at  $t$ . Instead, the stipulation only requires that the scientific hypothesis be a candidate for investigation (and not confirmation) at a later time  $t_{+n}$ .

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<sup>107</sup> It is not clear how the metaphysical projects that are determined by the principle of naturalistic closure also lead to a formulation of ontic structural realism, since ontic structural realism primarily has as its motivation the problems that befall scientific realism. Ladyman and Ross respond that ontic structural realism is not an *ad hoc* response to theory change, but is a result of our best physics (Ladyman and Ross 2007, 67).

As I will show in the next section, this possibility has significant implications for the claim that metaphysicians should only engage in radically naturalized metaphysics. Rather than being restrictive as to which forms of metaphysics should be endorsed, the principle of naturalistic closure leads to the endorsement of multiple metaphysical projects that Ladyman and Ross would not themselves endorse. This claim has the further implication that the ontic structural realist should not be too quick to reject other forms of metaphysics and it shows why the possibility of justifying other forms of metaphysics will be a positive, albeit resisted, result.

### 6.1.3 Unification and Modeling

Although radically naturalized metaphysics is the only adequate form of metaphysics set to the task of unifying the sciences and modeling the objective structure of reality, there are reasons that we should not believe that radically naturalized metaphysics is the only kind of metaphysics worth doing.<sup>108</sup> The projects that radically naturalized metaphysics is concerned with are worthwhile, but the justification for the claim that such metaphysics is possible is not found in radically naturalized metaphysics itself. The justification will be found in some other metaphysical hypothesis which is itself not restrained by the principle of naturalistic closure, thereby suggesting that the principle of naturalistic closure is not sufficient for radically naturalized metaphysics.<sup>109</sup>

Because radically naturalized metaphysics requires that the metaphysician engage in the task of unifying the sciences, it presupposes that the sciences are capable of unification. This presupposition, however, is not explanatorily significant when combined with scientific

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<sup>108</sup> For present concerns, I am assuming that Ladyman and Ross are correct in their characterization of radically naturalized metaphysics. I believe this assumption makes my argument stronger—*even if* radically naturalized metaphysics is the only form of metaphysics capable of  $x$ , it is not the only sort of metaphysics worth doing.

<sup>109</sup> I am assuming here that principle of naturalistic closure is at least necessary for radically naturalized metaphysics.



hypotheses, indicating that it is not immediately endorsed by the principle of naturalistic closure. Given two hypotheses  $H_1$  and  $H_2$ , where  $H_2$  is derived from fundamental physics, and given the claim  $C$  that the sciences are unified, we find that there is no additional service had by the conjunction  $H_1 \& H_2 \& C$  that  $H_1 \& H_2$  on its own does not provide.<sup>110</sup> A case in which  $C$  adds any additional explanatory force is if the specific *why*-question under consideration is *why do two hypotheses about the world from two different sciences aid us in an explanation?*

Why might Ladyman and Ross, then, be concerned with the project of unification? They appear to be taking a lead from Kitcher's own account of explanation (Ladyman and Ross 2007, 32 and 261). Kitcher argues that we are able to identify the unified causal structure of the world, since "to explain is to fit the phenomena into a unified picture insofar as we can" (Kitcher 1989, 500). This is not a claim about the unification of the sciences; it is an attempt to describe the relationship between causation and explanation. The claim that the world is causally unified in a way such that our explanations can offer insights to that causal structure may offer some motivation for radically naturalized metaphysics. But the claim that the world is unified is not to be found in the principle of naturalistic closure itself and, more importantly, appears to be in violation of the primacy of physics constraint, since fundamental physics does not tell us that the world is unified.

As Dupré (1993) and Cartwright (1999) have been at pains to argue, our understanding of the world, if we are to understand the world through the lens of science, is to see a "dappled world, a world rich in different things, with different natures, behaving in different ways" (Cartwright 1999, 1). Ladyman and Ross are aware of the arguments offered by Dupré and Cartwright (Ladyman and Ross 2007, 6). The rejection of the dappled view, however, is not

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<sup>110</sup> The idea of unification indicates that all of the facts of the world can be understood in terms of one general scientific theory, which some (e.g., Sider and Armstrong) indicate will be provided by the "final science."

accomplished by disputing the specific arguments, but attempted by critiquing the motivations for endorsing a non-unified account. The arguments offered by Cartwright and Dupré are much more sophisticated than Ladyman and Ross suggest—there is much more work needed to show why Dupré and Cartwright are mistaken.<sup>111</sup>

Second, not all scientists agree that unification is itself a serious scientific hypothesis. Although some scientists (e.g., Weinberg (1993) and Greene (2011)) do argue that unification is the project of science and is a serious hypothesis worthy of scientific pursuit, there are others (e.g., Woit (2006) and Smolin (2006)) who are skeptical of the enterprise of unifying the sciences. The contentiousness surrounding the possibility of unification makes it unclear if unification is a scientific hypothesis in the same sense as what scientists mean by ‘scientific hypothesis’ or if unification is a scientific hypothesis because some scientists believe that unification is possible.

My own view is that it is the latter, since there appears to be no direct evidence that would lead someone to infer that the sciences are unifiable. Furthermore, there does not appear to be any way we could either falsify or confirm the claim that the sciences are unified. At any point at which we might believe that the sciences have been unified, if we are capable of recognizing such a state, there may be other phenomena that have yet to be discovered which will require another science that are not part of the currently-unified picture. Furthermore, there is no scientific evidence available to indicate that we should believe that the sciences are capable of unification. At the moment, it appears that the unification of the sciences is only a hope.

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<sup>111</sup> My own view is that Dupré and Cartwright’s arguments indicate why we should not look to science to offer a unified account of nature, but that the very presupposition of the unified view is itself a metaphysical thesis—one that I believe provides valuable service to the sciences. To reiterate, the stance that the world is unified is a *metaphysical* thesis and not a *scientific* one.

Last, a further worry for the project of unification is that all previous attempts at unification have been inadequate to the task. If they were adequate, then we would have already succeeded at unification, in which case we would not be capable of recognizing that we have succeeded in unification, or we will have to wait longer to confirm that we are on the right track. What appears to be the case, though, is that the more attempts we make at unification, the more difficult the project becomes. Initially, the project of unification, at least in physics, appeared to have only required finding a connection between general relativity and quantum mechanics. Now, since quantum mechanics has itself become further diversified into such areas as quantum loop theory, quantum gravity, and quantum field theory, we need to first unify (or dispel) these fields before attempting to unify quantum mechanics with general relativity. The project, though, of interpreting these different fields in a way that will assist us in determining which one provides the accurate models is itself problematic. If history is any lesson in this regard, the hope for unification appears to be only that. The lesson to be gained is that the principle of naturalistic closure is not by itself sufficient to justify radically naturalized metaphysics—something else is needed.

The ontic structural realist can accommodate these lessons by taking into account the second stipulation of the principle of naturalistic closure (which explains what is meant by the expression ‘specific scientific hypothesis’). The structural realist can argue that the scientific hypotheses we are concerned with are those that *might* be investigated *later* than the time at which the metaphysical claim is under consideration. Rather than the metaphysician stating that her projects are entirely detached from science and that they do not bear on each other in any significant way, the metaphysician would be in a better position to state that, although her findings or theories may not be informative to any current scientific hypothesis, there may be one

that will be investigated later that might be related. Furthermore, since the scientific hypotheses that we are concerned with are only those that *might* be investigated, the hypotheses do not actually need to be investigated in order to vindicate the metaphysical claim in question. For this reason, it is only the possibility of there being a scientific hypothesis that would be investigated that warrants the consideration of the metaphysical claim.

To rephrase the metaphysician's position in a way that is in accordance with the principle of naturalistic closure: metaphysicians can proceed *a priori* in the investigation of matters upon which they claim science does not [yet] bear. This weakens the sense in which metaphysics ought to depend directly upon science if it is only dependent upon the possibility of scientific hypotheses being investigated. Furthermore, this account of metaphysics strengthens the extent to which science is dependent upon metaphysics since the possibility of scientific hypotheses will be justified by metaphysical theories about the nature of the world and what the future might be like given the present scientific data.

The way(s) in which science is dependent upon metaphysics is elucidated by the way(s) in which ontic structural realism is itself dependent upon metaphysical theses. By showing how a view of the philosophy of science is dependent upon metaphysical theses we can then infer how science is itself dependent upon those same claims. This outcome is a consequence of my belief that the philosophy of science justifies many methodological approaches to science, in which case the metaphysical theses that justify those claims in the philosophy of science, in turn, justify those scientific claims.

There are at least two ways in which ontic structural realism is dependent upon metaphysical projects that are not directly aimed at the unification of the sciences or modeling the objective structure of reality. First, part of the justification for ontic structural realism arises

from the principle of naturalistic closure itself. Radically naturalized metaphysics, however, is a result of the principle of naturalistic closure—not the other way around. The principle of naturalistic closure determines what is a metaphysically worthwhile project by determining which metaphysical claims we ought to accept—namely, those that result in the unification of the sciences or the modeling of the objective structure of reality.

Furthermore, the principle of naturalistic closure is itself not justified by science. The principle of naturalistic closure is concerned with which metaphysical claims should be entertained, not which scientific claims should be justified or how to go about practicing science. In other words, the principle of naturalistic closure is *about* metaphysics—or to use the contemporary parlance, the principle of naturalistic closure is a claim in the domain of *metametaphysics*. *Metametaphysics*, however, *is* metaphysics.<sup>112</sup> In particular, the metaphysician is also concerned with the kinds of statements we should adopt in our metaphysics and the way to go about investigating reality.

Like scientists, metaphysicians should have a good understanding of their tools and methods. Developing such an understanding is to be ensnared in metaphysical activities. For this reason, a discussion of which metaphysical claims ought to be entertained or considered relevant, as determined by the principle of naturalistic closure, is itself a metaphysical project—even though it happens to be a project that is not directly in line with radically naturalized metaphysics. More importantly, determining which metaphysical claims we should take seriously is a worthwhile metaphysical project, which is itself not directly aimed at the unification of the sciences or the modeling of the objective structure of reality.

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<sup>112</sup> See Chalmers et al. (2009).

Granted, the result of establishing the principle of naturalistic closure is radically naturalized metaphysics, but the establishment of the principle of naturalistic closure is on its own worthwhile. This result suggests that there is room for metaphysics that does not directly concern itself with projects as set forward by radically naturalized metaphysics. Furthermore, since radically naturalized metaphysics depends upon the principle of naturalistic closure and ontic structural realism is interested in radically naturalized metaphysics, the ontic structural realist should not restrict the very forms of metaphysics that have led to the establishment of these regulative principles.

Even if the ontic structural realist is still willing to reject the suggestion that other forms of metaphysical projects are worthwhile, she would do well to observe in which ways the very possibility of unifying the sciences and the possibility of modeling the objective structure of reality are both dependent upon metaphysical developments outside of radically naturalized metaphysics. I have already discussed how the unification of science is itself not directly a result of our current best sciences. There is still room, though, for a discussion of how the project of modeling the objective structure of reality is itself a metaphysical project.

To engage in the project of modeling the objective structure of reality requires the realist thesis that there is an objective reality and that reality has a structure capable of being modeled—both of which I endorse. If we look directly at the sciences, as the principle of naturalistic closure recommends, and more importantly if we look to fundamental physics, as recommended by the primacy of physics constraint, our best scientific theories do not say anything about there being an objective reality that possesses such a structure.

Van Fraassen (1998, 2007, and 2008) has argued that at best our scientific theories “save the phenomenon” but do not go any further in describing reality itself. I am in agreement at this

point that if we *only* look at science there is no reason to infer something about the structure of reality, or even that reality has a structure. I *do* believe that there is an objective structure to reality that science does help us understand, but this is due to metaphysical sympathies and not an understanding of science.<sup>113</sup> Similarly, the ontic structural realist should acknowledge that neither the principle of naturalistic closure nor primacy of physics constraint, separately or jointly, can lead to the inference that the project of modeling the objective structure of reality is the proper subject matter of metaphysics. This outcome is a result of working with a model-theoretic approach to science.

On the semantic view of scientific theories, models are taken to be accurate representations of the phenomenon (van Fraassen 2008, 309). It is how the model is used that determines whether the model is a reliable representation of a specific phenomenon, but it is due to a presupposition about the relationship between the structure of the model and the structure of the phenomenon that then determines whether the model is an accurate representation of the phenomenon. This discussion of the relationship of the structures between the phenomenon and the model will not be determined by science itself, or even by radically naturalized metaphysics. Although consistent with the principle of naturalistic closure (since making an inference about the structural relationships that occur between our models and the phenomenon aims at serving a scientific hypothesis) the stipulation is one from metaphysics about the relationship between models and their respective phenomenon—a metaphysical stipulation that van Fraassen suggests is not necessarily needed if our models are only aimed at saving the phenomenon that are of interest to us (van Fraassen 2008, 311).

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<sup>113</sup> My discussion of structure in the previous chapter indicates some of the reasons for maintaining the view that there is an objective structure; our survival is dependent upon our abilities to recognize and distinguish structural configurations.

To a degree, the motivation for going beyond the models themselves and claiming that the models *are* accurate representations of some phenomenon is due to the success of science in aiding us in orienting ourselves through the world. This at least gives us an empirical basis for adhering to the idea that science is useful, but to go further and say that the way that science models the phenomenon is an accurate depiction of how the world *is* violates a key Kantian insight that there is something over and above the models that is reality and science offers us insight to the structure of that reality.<sup>114</sup> There is some motivation, though, for believing that some models are more accurate in their depictions of the reality of which those phenomenon are constituent parts.

Given that we do not know which scientific theories are capable of vindicating our metaphysical claims, we should continue doing metaphysics in a way that is not always aimed at unifying the sciences or offering models of the objective structure of reality. Even the ontic structural realist has benefitted from metaphysics that is not in line with radically naturalized metaphysics.<sup>115</sup> In particular, ontic structural realism requires a form of metaphysics that is not itself radically naturalized metaphysics. It is not obvious that metaphysics will always be consistent with science, but the cost of continuing to do metaphysics appears to be very low. Some believe that the potential cost is the taking away of bright minds from subjects that are perhaps more pressing; it is this issue that leads Ladyman and Ross to “urge them to come back and rejoin the great epistemic enterprise of the modern civilization” (Ladyman and Ross 2007, 310). We should remind Ladyman and Ross that many of the great scientific and mathematical insights were accomplished by those (e.g., Einstein and Gödel) who themselves had whole-

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<sup>114</sup> Adherence to this Kantian line is a main motivation for proponents of epistemic structural realism.

<sup>115</sup> I have in mind here the claim that reality is “patterns all the way down” (Ladyman and Ross 2007, 228) and their development of Rainforest Realism (Ladyman and Ross 2007).



heartedly adopted metaphysical enterprises of the sort that Ladyman and Ross wish to reject. The lingering issue then is if such advancements could have been made without having realist commitments.<sup>116</sup>

### 6.1.3.1 Summary

What I have set out to accomplish so far in this chapter is to show that ontic structural realists such as Ladyman and Ross have underappreciated some of the ways that their own project has benefitted from metaphysics, and that their attempt to formulate a regulative process for determining which metaphysical claims we should take seriously (in the form of the principle of naturalistic closure) in fact opens room for nearly any metaphysical project to be pursued given the possibility that it *might* aid some scientific hypothesis (if not in a positive form, then perhaps in a negative form). One might suggest that we drop ‘might’ from the stipulation. I believe this would undermine much of science, though. Much of science involves surprising routes and we would not want to undercut our future endeavors simply because we believe we have a good handle on what science will tell us in the future.<sup>117</sup> For this reason, the ‘might’ clause allows room for science to continue its exploratory role—a worthy cost to allow metaphysicians to continue as they have.<sup>118</sup>

To sum up: There are metaphysical projects that do not directly concern themselves with the unification of the sciences or the modeling of the objective structure of reality. These

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<sup>116</sup> This claim allows for the possibility that realist commitments are only psychologically beneficial to those who engage in scientific endeavors.

<sup>117</sup> This thought leads me to be sympathetic to Feyerabend’s *Against Method*, in which he states, “All methodologies have their limitations and the only *rule* that survives is *anything goes*” (Feyerabend 2010).

<sup>118</sup> Not all ontic structural realists are committed to the idea that we should wait for science to tell us when a metaphysical claim will be useful. French (2014) invites us to “pillage” from metaphysics what we can make use of. I have not resolved my own views of this technique, but it at least suggests that verification is not our only source of vindication (a lesson to be adopted from the fall of logical positivism).

metaphysical projects are still worth doing. A method for distinguishing worthwhile metaphysics from others is still needed, which is something I address in the argument for attenuated methodological naturalism in Chapter 1. With these considerations, we come to realize that, although radically naturalized metaphysics may not be the only kind of metaphysics worth doing, the allowance of other forms of metaphysics might perform a greater service on its behalf.

## **6.2 Ontic Structural Realism and Process Metaphysics**

The aim of metaphysics is to make inquiries into the various aspects of reality. Doing so involves taking into consideration both everyday experiences and contemporary empirical developments. As the previous section of this chapter show, the ontic structural realist goes too far in pursuing a radically naturalized metaphysics that contends that the only worthwhile tasks for the metaphysician are to unify the sciences and model the objective structure of reality. In large part, this is due to many of the metaphysical assumptions needed for a radically naturalized metaphysics to succeed are themselves not a direct result of tasks set forward by ontic structural realists who embrace a radically naturalized metaphysics. Among these assumptions is the general metaphysical framework that we should accept for the purposes of understanding the scientific details that are taken into consideration when working towards the unification of the sciences. The adoption of a metaphysical framework also plays a substantive role in determining what reality is taken to be like for the purposes of developing an adequate model (assuming that accuracy, and not just usefulness, is among the criteria for adequacy). In choosing which metaphysical framework to adopt, the ontic structural realist is more likely to adopt a process framework rather than a substance ontology.

### 6.2.1 Commonalities

There are at least three significant commonalities between ontic structural realism and a process framework that lend credence to the view that the ontic structural realist can adopt a process metaphysics. First, both ontic structural realists and process metaphysicians appeal to contemporary naturalistic developments to advocate for their respective positions. I have already discussed in earlier chapters how process metaphysicians take into consideration developments from both physics and biology. The first section of this chapter specifically looks at how the ontic structural realist takes into account developments from physics—specifically to uphold the primacy of physics constraint. These methods further highlight why the ontic structural realist (esp., Ladyman and Ross) are opposed to a metaphysics that does not take into consideration scientific developments. They write,

Our core complaint is that during the decades since the fall of logical empiricism, much of what is regarded as ‘the metaphysics literature’ has proceeded without proper regard for science. The picture is complicated, however, by the fact that much activity in what is classified as philosophy of science is also metaphysics, and most of this work is scientifically well informed. This book is an exercise in metaphysics done as naturalistic philosophy of science because we think that no other sort of metaphysics counts as inquiry into the objective nature of the world.

(Ladyman and Ross 2007, 7)

Although many of their remarks are polemical (see above for the comparison between Ladyman and Ross’ and Ayer’s stances on metaphysics), ontic structural realists are interested in understanding how both philosophy and science can make progress in understanding the nature of the world. This does not mean, however, that we should “read off the metaphysics” from the

physics. Doing so runs the risk of the problem of the underdetermination of metaphysics by physics, which states that more than one metaphysical theory can be consistent with the currently available empirical evidence, so that empirical considerations alone cannot select a unique metaphysical theory (French and Krause 2010). Many ontic structural realists have already attempted to overcome this difficulty (French 2014, 24-47). The lesson to be learned from these attempts is that the ontic structural realist (even Ladyman) is not committed to reducing metaphysics to physics. Instead, the metaphysician will need to maintain contact with the scientific developments if she wishes to provide a more complete picture of reality. This leads me to the second commonality that ontic structural realists and naturalistically informed process metaphysicians share.

Both ontic structural realists and process metaphysicians provide naturalistic reasons for rejecting key features of substance metaphysics—namely, that there exist ontologically fundamental, independent, and nonrelational individuals (or substances).<sup>119</sup> Earlier chapters emphasize how the naturalistic considerations that process metaphysicians maintain result in the suspending of judgment on, or in some cases rejection of, substance metaphysics. In a similar way, the ontic structural realist allows for the possibility that if we are interested in understanding the nature of reality it will be best understood in terms of structures. The result is that the things we take to constitute the relations are not themselves ontologically fundamental. Specifically for Ladyman and Ross, “the important real patterns in science are not reducible to facts about the intrinsic properties or natures of individual objects. [We] defend a metaphysics that does not take individual things to be fundamental” (Ladyman and Ross 2013, 109). Along

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<sup>119</sup> Chakravartty provides insight to what a non-eliminativist ontic structural realism might entail, but this is used to develop a dilemma for ontic structural realism in general that he resolves by advocating for object realism (Chakravartty 2012, 187). Since this is not a view generally held by ontic structural realists, I will not give the non-eliminativist form further consideration in this chapter.

similar lines French writes, “There may be as many structural realisms as there are structural realists but the most recent form of this view suggests that what it is about a theory that corresponds to reality are certain structural relations, while the relata themselves are regarded as ontologically eliminable” (French 1998, 107).<sup>120</sup> In later works, French states that although the objects that serve as relata are not ontologically fundamental, they show up at the level of representation in scientific practice in the usage of group- and set-theoretic approaches (French 2012, 3).

These passages indicate how ontic structural realists understand the view that objects are ontologically fundamental, independent, and nonrelational as being at odds with contemporary scientific developments. The suspension of metaphysical theories because of their conflict with science is consistent with the attenuated methodological naturalism I defend in Chapter 1. Furthermore, the way in which the aforementioned ontic structural realists reinterpret those objects that were previously thought as being fundamental allows those objects to still figure into explanations at some meta-level of analysis. Ontic structural realists understand that language that makes reference to those objects may still be useful for understanding deeper aspects of both scientific theories and the world. In particular, those entities are treated as epistemic bookmarks, but are not treated as ontological indicators. Allowing independent objects to be epistemic bookmarks, without entirely dismissing them from the contemporary ontological debate, is consistent with the attenuated methodological naturalism I defend since it allows the possibility that the object may warrant relabelling as being ontologically fundamental despite contemporary science indicating that it should not be thought of as such.

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<sup>120</sup> The possibility of there being relations without relata is a point for which ontic structural realism has been most criticized (Nounou 2012, 118). I will discuss this objection in more detail below.

The shift away from a thing-based ontology and towards the structuralist one emphasizes the third commonality between ontic structural realists and process metaphysics I wish to address, namely that they both strive for a monocategorical ontology. The former understands structures as being the fundamental constituents of reality while the latter understands processes as the fundamental constituents. Without objects, at least of the kind advocated for by neo-Aristotelians, the ontic structural realist understands reality to be fundamentally comprised of structures. Ladyman and Ross write, “From the metaphysical point of view, what exists are just real patterns...Science motivates no separate metaphysical theories about objects, events, and processes” (Ladyman and Ross 2007, 121). The appeal to processes is consistent with the ontic structural realist’s own attempts to unify the sciences. Ladyman and Ross write, “As we’ve explained, attention to the proliferation of non-reducing patterns of causal explanation in special sciences largely defines the contemporary naturalistic (unificationist) metaphysician’s mission. For this process, process theories are one possible piece of useful ordinance” (Ladyman and Ross 2007, 264).

These passages provide textual support for the idea that ontic structural realism is not at odds with a naturalistically-informed process metaphysics. Furthermore, the previous chapter provides insight to how ontic structural realism benefits from the adoption of process metaphysics. In particular the previous chapter’s argument that the process metaphysician can understand structures in terms of metastable processes assists the ontic structural realist in responding to objections.

## 6.2.2 Objections to Ontic Structural Realism

The main objection to ontic structural realism is its allowance for the counterintuitive possibility of there being relations without relata.<sup>121</sup> This objection occurs in many places, but the idea is if we allow for the relata to be defined in terms of their relations, then it is unclear exactly which structures with which we should concern ourselves.<sup>122</sup> Ladyman and Ross commit themselves to the view that there are only relations and no relata, which they maintain further commits them to the view that “its relations all the way down” (Ladyman and Ross 2007, 152). In earlier chapters, I argued that it is a mistake to think that there is some fundamental level for fundamental investigation, which would indicate that I am sympathetic to their claim. Since I believe that the metaphysician should provide an account of both the empirical data and our commonsense everyday experiences, their emphasis on relations as described by science, however, leaves the metaphysician’s work only halfway complete.

In large part, their hyperbolic language leads Ladyman and Ross to provide a somewhat disingenuous response when they state that “we precisely do *not* want to take the existence of individuals for granted, since we hold them to be only epistemological bookkeeping devices” (Ladyman and Ross, 240). I am in complete agreement; we should not take the existence of individuals for granted—we should suspend judgment on their existence when it would be at odds with contemporary science. Yet something like individuals do appear in our theories, even if only for the purposes of “epistemic bookkeeping.” Such bookkeeping occurs at a meta-level of analysis that is not centrally concerned with those aspects of reality that show up to us in everyday experiences or, for Ladyman and Ross, in the special sciences. It is important, then, for

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<sup>121</sup> Thanks to both John Symons and Eric Winsberg for bringing this problem to my attention.

<sup>122</sup> This objection is set-out by Rickles (2012), Psillos (2006), Busch (2003), and Esfeld and Lam (2008).

the metaphysician to provide some account of how we should understand those individuals that serve as relata if they are not really individuals.

The idea of a structure being a metastable process helps. A metastable process is one that maintains some degree of stability for a duration. Depending upon the methods of analysis or observation a person employs, either in everyday experience or in the sciences, those methods will allow a person to pick out particular aspects as being individuals. In particular, the methods a person uses to determine the relation that the observer has with the phenomenon being assessed. This relation is itself a metastable configuration that is dependent upon the individual, phenomenon, and methods being used by the individual to better understand the phenomenon. Once the methods shift, our understanding of the object that is being epistemically tracked will also be altered, resulting in a reconfiguration of our understanding of the more general process of which the methods, person, and phenomenon are constituents. So although it might be “relations all the way down” the process metaphysician can explain why some processes appear to us as being individuals without having to commit herself to the ontological existence of those individuals (as the neo-Aristotelian would have it).

Second, ontic structural realism meets additional resistance since its appeal to structures results from observations of mathematical structures that are sustained despite changes in scientific theories. This criticism can be summarized as follows: Since the structures with which the ontic structural realist concerns herself are mathematical structures, it appears that the ontic structural realist is committed to a form of either Pythagoreanism or Platonism (Donnchadh 2014). If this is the sort of structures with which the ontic structural realist concerns herself, then she would encounter the sorts of epistemic difficulties that beset different varieties of Platonism. Ladyman and Ross summarize this objection: “To say that all there is are relations and no relata,



is therefore to follow Plato and say that the world of appearances is illusory” (Ladyman and Ross 2007, 152). This line of criticism, however, overlooks key components of ontic structural realism that indicate the ontic structural realists are not Platonists.<sup>123</sup>

Formal structures that occur in the form of scientific theories and models are representations of real patterns (Ladyman and Ross 2007, 120). The idea of a *real pattern* is adopted from Dennett (1991). Ladyman and Ross write,

[For] a pattern to be real—for the object of a scientific theory or other description to be deemed an aspect of objective reality—it must be such that a community of inquirers who wished to maximize their stock of true beliefs would continue to be motivated to track the pattern notwithstanding any shifts in practical, commercial, or ideological preferences that are not justified by new evidence bearing on the epistemic redundancy or non-redundancy of the pattern. (Ladyman and Ross 2007, 36)

This account of a real pattern depends upon many similar features to those that allow us to understand structures in terms of a process framework. First, it upholds some common sense aspects of stability as involving some degree of similitude being sustained over a duration of time; the community of inquirers track the same pattern. Second, it is possible for the various practical, commercial, or ideological preferences to shape the inquirers’ understanding of the pattern as such, which can then further modify the methods they use for tracking the pattern. For this reason, there is no single established stable relation between the inquirers and the pattern, but it is a metastable one that can be altered. On this view, then, the pattern is itself a process that the inquirers have identified as being relevant for tracking purposes, and, in accordance with

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<sup>123</sup> Ladyman and Ross do, however, acknowledge the possibility of their account being a naturalized Platonism (Ladyman 2007, 158).

understanding how the pattern may be identified as an individual at some meta-level of analysis, it is a process that is physically instantiated in the world that allows such tracking to occur.

This is a preferable response to Ladyman and Ross' own response to the difficulty of avoiding a Platonic account of structure:

Physical structure exists, but what is it? If it is just a description of the properties and relations of some underlying entities this leads us back to epistemic structural realism. What makes the structure physical and not mathematical? That is a question that we refuse to answer. In our view, there is nothing more to be said about this that doesn't amount to empty words and venture beyond what the [principle of naturalistic closure] allows. The 'world-structure' just is and exists independently of us and we represent it mathematico-physically via our theories (Ladyman and Ross 2007, 158).

As Ladyman and Ross acknowledge, this (unsatisfactory) response results from their own commitments to the principle of naturalistic closure. In the previous section, however, I discuss why such strict adherence to the principle of naturalistic closure is limiting to the more general project of developing a naturalized metaphysics. By adopting a process framework, the ontic structural realist can then provide a clearer account of how the metastable processes are the structures being given the mathematico-physical representations.

French also provides a more palatable response regarding the types of structures with which the ontic structural realist concerns herself. He writes,

[The] 'mathematical structure' will be arrived at via an abstraction from physical patterns or structure. Now, of course, abstraction and idealization play a significant role in the construction of scientific models. However, that the

*representation* of physical structure involves such abstraction does not imply that the structures itself should be regarded as abstract, in the way that a mathematical structure (French 2014, 207).

In a similar way, then, to how real patterns are capable of being understood in terms of metastable processes, the objects that show up in group- and set-theoretic approaches are themselves capable of being metastable descriptions depending upon the specific type of processes they happen to instantiate.

Aside from the objections already discussed in the literature, the account that I have presented here in responding to these objections may turn the ontic structural realist picture into an epistemic one. Someone might think that there are ultimately processes and then there are stable processes that allow for representations in either group- and set-theoretic models of those processes. In which case there would be something over and beyond the structures, but that, at most, we can only know those structures.

There are at least *a priori* reasons for resisting the collapse of ontic structural realism into epistemic structural realism. The idea is that if we understand structures as being metastable processes, then any process, to exist as such, is to maintain some degree of metastable configuration as a process. This is in large part due to the assumption that there are no vacuums; in which case, any process will be situated in relation to some other process that allows for the relation between what is taken to be a nonstable process (under one description) and another process is to instantiate some more general metastable process. In other words, so long as there exists more than one process, those processes are themselves aspects of a metastable process that is instantiated by the relation of those processes.

Even if someone upholds the monist view that there is only one process, then that process can still be said to be metastable (or even stable if treated as a limit) insofar as it exists. This view is in line with the form of *priority monism* upheld by Shaffer (2007), in which the distinctions made in the world are ontologically derivative. This, however, is unlikely to be the case given that there are instances of the different ontological types of processes discussed in the previous chapter and these different types are the result of varying configurations of dynamic stuffs—their dynamics determining what type of process they instantiate.

### 6.2.2.1 Summary

This section aims to establish two claims: 1) ontic structural realists can adopt a process metaphysics, and 2) the ontic structural realist benefits from the view of structures as being metastable processes. The first claim is supported by commonalities between ontic structural realism and a naturalistically informed process metaphysics. Specifically, they both contribute to the development of a naturalized metaphysics, shift away from a substance ontology, and pursue a monocategorical ontology. The second claim is supported by the ontic structural realist benefitting from the adoption of a process account of structure that understands structures in terms of metastable processes. In particular, doing so allows the ontic structural realist to respond to objections regarding the counterintuitive result of having relations without relata and avoiding charges of Platonism. In addition to responding to these objections, this process approach allows the ontic structural realist to accommodate both scientific developments while explaining common sense experiences. The result of these two claims being that not only can the ontic structural realist accommodate a process framework, but that she should.

### 6.3 Conclusion

The aim of this chapter has been to argue that the ontic structural realist can accommodate a process framework. This is due to both process metaphysicians and ontic structural realists adhering to some form of (non-radical) methodological naturalism, dispelling key assumptions of substance metaphysics, and developing a monocategorical ontology. Furthermore, the ontic structural realist can understand physical structures in terms of metastable processes.<sup>124</sup> Whereas the present chapter has provided some incentive for doing so in light of previous objections to ontic structural realism, the next chapter will rely upon the idea of structures as being metastable processes for the purposes of understanding natural laws.

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<sup>124</sup> In addition to Ladyman and Ross' own discussion of processes in consideration of Salmon's process account, French also begins gesturing to the possibility of accommodating processes in his discussion of Dupré's account of living organisms as life processes (French 2014, 350).

## CHAPTER 7: CONCLUSION AND IMPLICATIONS: FROM ATTENUATED METHDOLOGICAL NATURALISM AND PROCESSES TO LAWS

### 7.0 Introduction

In the preceding chapters, I have shown how both metaphysical and scientific considerations inform our ontologies with respect to developing accounts of substances, processes, and structures. In particular, I have shown how a substance-based ontology is problematic when adopting a neo-Aristotelian framework that takes common sense as the foundation for developing metaphysical theories. A second chapter dealing with substance-based ontologies argues that we have naturalistic reasons for suspending judgment to the adoption of neo-Aristotelian substances, since both contemporary physics and biology call into question the existence of substances that are ontologically fundamental, non-relational, and independent. Assuming that a theorist is under some obligation to specify an ontology, the calling into question of a substance-based ontology provides incentive to explore alternatives. Given the naturalistic considerations that provide reasons for suspending judgment on a neo-Aristotelian substance-based ontology, I show that these very same developments provide reasons for pursuing and further developing a process-based metaphysics. I then argue that a process-based metaphysics can be shown to be consistent with a metaphysics of structure. Doing so provides a basis for arguing that the ontic structural realist can adopt a process framework since the ontic structural realist, along with process metaphysicians, rejects a robust account of things.

The ontic structural realist has additional reasons for adopting a process framework. In particular, doing so offers additional justification for the account of laws based on modal and causal relations that an ontic structural realist, such as French (2014) might seek to develop. are employed. As this chapter will discuss, neither processes nor symmetries are independently sufficient for explaining the account of modality that distinguishes ontic structural realism from other structuralist positions. Having shown how ontic structural realism is at least consistent with a process framework, while fundamentally at odds with a substance ontology, this chapter provides a first step toward discovering what a process account of laws will be like for the ontic structural realist.

The first section provides a sketch of how theoretical sympathies in either general metaphysics or philosophy of science have significant implications for one's account of laws. Although there are clear correlations between realist and antirealist accounts, it is not obvious what the ontic structural realist's account of laws would be (7.1). The second section discusses the interrelatedness of nomic concepts such as lawhood, cause, and modality to understand how these relations provide insight to what an ontic structural realist might say about laws from within a process framework (7.2). The final, concluding, section provides a summary of what has been accomplished, and an account of the relevance of this dissertation to future developments on the topic of laws (7.3).

### **7.1 Theoretical Correlates and Laws**

Recent literature concerning laws of nature highlights the close relationship between general metaphysics and philosophy of science. In particular, a person's theoretical commitments in either area have direct implications for her stance on laws. For example, Dretske, Tooley, and Armstrong each independently developed an account of laws (henceforth, the *DTA account*) that

takes laws to be second-order relations among universals. Although each of them maintains a different account of universals and there are subtle, yet significant, distinctions between their accounts, it is by allowing universals in their ontology that permits their account of laws to involve such universals.

Whereas the DTA accounts of laws can be said to have Platonic origins, Bird develops an account of laws from within a neo-Aristotelian framework. His neo-Aristotelian sympathies lead him to endorse an ontology that includes dispositions, powers, and essences in addition to individual substances. His account of laws has two significant features resulting from this ontology: 1) Laws are metaphysically necessary because 2) Laws are taken to supervene on those properties that essentially have their dispositions (Bird 2007, 204-205).

Not all *nonreductive* accounts of laws make use of either universals or dispositions.<sup>125</sup> For example, Carroll maintains that without laws “*there would be little else*” (Carroll 1994, 3; emphasis in original). In particular, our understanding of causes, dispositions, counterfactuals, perception, and everyday objects is dependent upon our understanding of laws (Carroll 1994, 10). Rather than appealing to universals, Carroll understands laws in commonsense terms consonant with a Laplacean worldview (Carroll 1994, 160).<sup>126</sup> Lange also does not make use of universals in his argument that laws of nature are to be grounded in primitive subjunctive facts—facts about what might occur in the world under counterfactual conditions (Lange 2009, ix). In both Carroll’s and Lange’s accounts, laws are appealed to for understanding other nomic

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<sup>125</sup> To say that a law of nature is nonreductive does not entail that the concept of *lawhood* is not analyzable, only that what it is to be a law is not reducible to the facts about the world the laws are said to govern.

<sup>126</sup> Carroll’s discussion emphasizes that we should not think that we are in a Laplacean world or that we can have knowledge of all facts of the world, but only that our understanding of laws results from thinking of the world as being Laplacean.



concepts such as cause, chance, counterfactuals, and modality—without reducing laws to what is or has been the case or appealing to relations among universals or dispositions.

Although the previously mentioned accounts of laws do not reduce laws to descriptions or facts about what is or has been the case, there are other, more ontologically sparse accounts that seek to understand laws *only* in terms of such facts. These *reductive* accounts are often called *Humean*. Interestingly, Hume never provided an account of laws. To account for this homage Lewis famously states, “Humean Supervenience is named in honor of the great denier of necessary connections. It is the doctrine that all there is to the world is a vast mosaic of local matters of particular fact—just one little thing and then another” (Lewis 1986, ix). For present purposes, although I think it is an unfortunate label, it is not important whether or not Humean accounts are appropriately labeled as such; what is important is the Humean’s denial of necessary connections.

The explicit rejection of necessary connections has served as a foundation for at least two reductive accounts of laws. First, Schaffer argues for an account in which causation is reducible to history and the laws of nature, and those laws are themselves reducible to history (Schaffer 2008, 82). History, on Schaffer’s view, is understood as being “the fusion of all events throughout spacetime” (Schaffer 2008, 83). To say that the laws of nature are reducible to history, then, is to argue that one should look no further than the “pattern of events.”<sup>127</sup> This view provides a simple reductionist account that may be understood as a *regularity* view of laws. In particular, this treatment of laws understands them as being exceptionless regularities capable of generating “true universally quantified conditionals” (Schaffer 2008, 83).

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<sup>127</sup> This may also be understood in terms of a supervenience account, in which the laws are understood to supervene on events.

The second reductive (or supervenience) account is more nuanced than Schaffer's. Often referred to as the *Best System Analysis*, the view has been developed by Mill (1973), Ramsey (1990), and Lewis (1973), and has been most recently advocated for by Beebe (2000). Lewis provides a clear summary of the account when he writes, "[A] contingent generalization is a *law of nature* if and only if it appears as a theorem (or axiom) in each of the true deductive systems that achieves a best combination of simplicity and strength" (Lewis 1973, 73). The denial of necessary connections indicates that the laws themselves neither determine the facts that will occur or are themselves necessary. Instead, the laws at a world are determined by the facts at that world. The theorems (or axioms) to be taken as candidate laws are those that we, or an idealized epistemic subject, would derive after having arranged all of the known facts in a deductive system. In keeping with the traditional appeal to laws for the purposes of providing explanations, the laws would include not only those theorems (or axioms) derived from the deductive system, but also those theorems (or axioms) capable of explaining the phenomena that are of interest to and potentially made intelligible by us. This has interesting implications for the metaphysics of laws. On this view, laws are determined by the structure of the deductive systems, which are dependent upon the contingent facts of the world that are used for the purposes of deriving the theorems (or stipulating the axioms) and are further determined by our cognitive limitations and pragmatic explanatory concerns.<sup>128</sup>

Despite the stark contrast between reductivists and nonreductivists, they both maintain realist commitments to laws. The ways in which they maintain such commitments, as I have discussed, indicate the account of laws that they endorse. Not everyone is a realist, though.

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<sup>128</sup> Although the majority of Humeans forego the idea that laws of nature govern, Roberts maintains an ontology comprised of nothing beyond the Humean mosaic while arguing that laws govern insofar as there are "certain logical possibilities that are denied us by the lawhood of laws; we natural creatures cannot do certain things, because no matter what we might do, those things would remain undone" (Roberts 2008, 365).

Those who have developed antirealist and instrumentalist views have also made claims regarding the nature of laws. For example, Cartwright, an instrumentalist about science, recognizes that local laws may be understood realistically about a given phenomenon, but only insofar as they figure into scientific models (Cartwright 1983, 18). This is consistent with her patchwork view of laws that results from understanding the world through science, and, since the sciences are not unified, she argues that we should not maintain that there are general universal laws (Cartwright 1999).

Van Fraassen proposes an even less sympathetic view of laws resulting from his constructive empiricism, which maintains the perspective that “scientific activity is one of construction rather than discovery: construction of models that must be adequate to the phenomena, and not discovery of truth concerning the unobservable” (van Fraassen 1980, 5). Since laws, according to van Fraassen, do not contribute to scientific models, or any significant scientific activity for that matter, then we should dispense altogether with the idea that there are laws (van Fraassen 1989, 181-184).

The upshot of the above survey is to highlight how theoretical commitments in either metaphysics or philosophy of science have direct implications for what is taken to be an acceptable account of laws. The positions I have considered are from either extreme of the realist / antirealist spectrum. Structural realism, as discussed in the previous chapter, is a position developed in response to the difficulties facing both realism and antirealism. Given the trend I identify above in understanding why a person holds some stance on laws and not others, it appears that the structural realist should also take a stance on the issue of laws. Structural

realists, however, have not (until very recently) begun to discuss the nature of laws.<sup>129</sup> What it is for something to be a law for the structural realist remains unclear. For this reason, some account of what the structural realist should say about laws is called for.

The remainder of the chapter clarifies the ontic structural realist's stance on laws. In particular, I illustrate how since the ontic structural realist is a realist about laws, in addition to maintaining realist stances on modal and causal relations, she will need to adopt a process framework. This discussion provides support for the more general claim that an ontic structural realist should adopt a process metaphysics.

## 7.2 Laws, Causes, and Modality

The form of structural realism that I am specifically concerned with is ontic structural realism. The motivation for considering laws at all, however, seems to be mostly epistemic, since laws have traditionally been appealed to for the purposes of providing explanations (Salmon 1989, 12). The connection between laws and explanation may provide some reason to give an account of laws from the perspective of epistemic structural realism.<sup>130</sup> Van Fraassen, however, has provided multiple arguments opposing the idea that laws serve the epistemic roles that have been attributed to them. In particular, he argues that laws are inadequate to the tasks of offering theories of explanation, confirmation, necessity, and serving as a guideline to the general aims of science (van Fraassen 1989, 184). The resulting burden for the epistemic structural realist is to overcome these arguments.

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<sup>129</sup> Although Ladyman and Ross (2007) provide some of the first comments on the ontic structural realist's view of laws, ontic structural realists do not make direct contact with the metaphysics of laws literature until Cei and French (2014), French (2014), and Berenstain and Ladyman (2012).

<sup>130</sup> A further discussion on the nature of *explanation* may provide some insight to what the epistemic structural realist would have to say about laws. Exactly what is to be explained, however, is a pragmatic issue left to the interests of the person providing the explanation and interests and abilities of the receptive audience.

The ontic structural realist, however, has a different motivation for discussing laws. According to Ladyman and Ross, “a law is simply a real pattern, described by a structural claim, that is hostage to disconfirmation by any measurement taken anywhere in the universe” (Ladyman and Ross 2007, 289); whereas the activity of discovering a law is “just a matter of correctly describing real patterns” (Ladyman and Ross 2007, 288). These patterns are picked out by fundamental physics, and since, according to the primacy of physics constraint, the special sciences are reducible to fundamental physics, any pattern that is picked out by the special sciences will be identified as a real pattern only if it also shows up in fundamental physics. The identification of these real patterns, then, is a task that contributes to the unification of the sciences since it is a method for discovering what is common to both the special and the fundamental sciences. Laws, then, contribute to the more general task of naturalized metaphysics, which is to unify the sciences. Given this appeal to laws as being a metaphysical endeavor, and not a purely scientific endeavor, the ontic structural realist does not succumb to the same burdens as the epistemic structural realist.

The shift away from the implementation of laws for the sole purposes of scientific activities provides insight to the account of laws the ontic structural realist would endorse. On French’s Viking approach, “the products of analytic metaphysics can be regarded as available for plundering” (French 2014, 50). According to this view, the concept of *lawhood* is something the ontic structural realist can “pillage” for the purposes of understanding other nomic concepts such as *cause* and *necessity*. What is pillaged, however, depends upon what is found to be of use, value, or interest to the pillager. This Viking approach, then, would reduce ontic structural realism to a form of pragmatism, or, to keep in line with French’s colorful metaphor, barbarism.

Although sustaining any line of inquiry requires the attention of those who are engaged in the inquiry, even French maintains an account of laws that goes beyond merely pragmatic considerations. He writes, “the ontology we should ‘read off’ our physics should be one of laws and symmetries, understood as features of the structure of the world” (French 2014, 64). Furthermore, Ladyman and Ross’ account not only contributes to the unification of the sciences but also aids in the completion of an account of reality. For Ladyman and Ross, to identify a law is to identify an exceptionless real pattern. This stance has significant implications for their preferred ontology. They write; “Because we think fundamental physics describes some such real patterns, we believe there are universal laws” (Ladyman and Ross 2007, 289). Such an ontology is one that includes laws, and since these laws are indicators of real patterns, ontic structural realists uphold a realist account of laws.

This realist commitment to laws is what allows ontic structural realists to account for the objective modal structure of nature. In fact, it is these laws (understood as constraints) that determine modal facts. Ladyman and Ross write,

If there are structural facts about the whole universe, and these facts constrain all the facts about all particular regions of the universe... then the only necessity in nature is furnished by these constraints. The constraints—that is, the structures themselves—are real patterns. (Ladyman and Ross 2007, 288)<sup>131</sup>

It is not exactly clear how Ladyman and Ross take laws to be able to constrain these modal features. Instead, we see them treating modality in general as primitive (Ladyman and Ross 1998, 153) which is consistent with Ladyman’s earlier discussions of structural realism

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<sup>131</sup> More recently, Berenstain and Ladyman use this claim as the basis for their argument that a realist commitment to laws and modal necessity is a feature of ontic structural realism that distinguishes their view from structural empiricism (Berenstain and Ladyman 2012).

(Ladyman 1998, 418).<sup>132</sup> French goes even further than Ladyman and Ross in providing laws with a more robust role in determining the modal structure of the world since laws, along with symmetries, are inherently modal (French 2014, 264). In particular, it is the laws and symmetries that ground the properties and behavior of putative objects (French 2014, 183).

So far then we can understand the ontic structural realist as upholding a realist commitment to laws insofar as those laws are what allow for modal structures. Van Fraassen, however, is unfriendly to the idea of modality (at least in the form expressed by modal realists who appeal to possible worlds). He writes, “the golden road to philosophy which possible-world ontologies promise, leads nowhere” (van Fraassen 1989, 93). Furthermore, he expresses reservations about any appeal to laws of nature. So, even if we were to allow for the idea that there are physical modal relations of the kind that French endorses, then why require laws to do this work, and not just symmetries?<sup>133</sup>

French’s account differs from the structural empiricist’s by including modality. The structural empiricist’s account, however, only requires a symmetrical structure and claims to accommodate what we want from an account that also includes modality since “causal and modal discourse describes features of our models, and not features of the world” (van Fraassen 1989, 214). If French wishes to include modality, then he will need to either explain how modality can be generated from a symmetrical base alone or explain what, in addition to symmetries, accounts for modal relations.

First, the ontic structural realist is committed to objective modality. Ladyman and Ross explicitly state that “our commitment to objective modality is a further departure from van Fraassen’s own position” (Ladyman and Ross 2007, 118). Furthermore, Berenstain and Ladyman

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<sup>132</sup> French (2006) also expresses sympathies with this view of modality being treated as a primitive.

<sup>133</sup> Thanks to Otávio Bueno for bringing this point to my attention.

argue that a reliance on objective modality is “integral to arguments for scientific realism” (Berenstain and Ladyman 2012, 150); Ladyman and Ross argue that the modal structure is necessary for the transmission of information (Ladyman and Ross 2007, 188); and French argues that the fundamental (objective) structure is “*inherently* modal in the sense of encoding the full range of allowable physical possibilities” (French 2014, 319; emphasis in original). For these reasons, and many more that I have not listed, the ontic structural realist is not readily willing to dispense with the idea of objective modality.

Second, it is not obvious that a symmetrical base alone can generate a modal structure. Modality is an inherently asymmetrical notion. In particular, a modal relation is an asymmetrical dependence relationship between some actual structural configuration  $@S$  and those structural configurations that are either at least consistent with  $@S$  or entailed by  $@S$ . Those configurations that instantiate the first disjunct are those structural configurations that are possible ( $\diamond S$ ) and those configurations that fall under the second disjunct are necessary ( $\Box S$ ). Although this entails that what is actual plays a role in determining what is either possible or necessary, it is also the case that what is actual depends on what is either possible or necessary—those things that are actual are at least possible, and some things that are actual are even necessary. Regardless of how someone opts to describe the dependence relationship, in neither case will the order of dependence be symmetrical (i.e.,  $(@S \text{ depends on } (\Box S \vee \diamond S)) \rightarrow \neg((\Box S \vee \diamond S) \text{ depends on } @S)$ ).

If we understand modal relations to be asymmetrical relations of dependence, then some account needs to be given of how an asymmetry can result from symmetries without some other (asymmetrical) element. It is not readily clear how this account is to be developed.<sup>134</sup>

Mathematically, symmetries are transformations of some structural configuration  $S/$  that result in

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<sup>134</sup> This is an issue deserving of its own book length treatment.



some other structural configuration  $S_2$ , in which  $S_1$  and  $S_2$  maintain the same *relevant* structural aspects. This can be taken as the *automorphism view* of symmetry (Weyl 1952, 45). This account of symmetry is carried out in theoretical physics in which objects, such as elementary particles, are “invariant under the symmetry groups of particle physics” (Ladyman and Ross 2007, 147). Less abstract, physical symmetries are usually instantiated in terms of proportion (Weyl 1952, 3). Yet we do not observe purely bilateral symmetry in physical objects; some distinguishing trait can usually be observed between left and right upon close enough examination. In these cases, the asymmetry can usually be attributed to some other asymmetry. These observations have led some to endorse the general principle that only asymmetries can produce asymmetries (Weyl 1952, 32).

Van Fraassen further addresses some of the difficulties with endorsing the view that symmetries can generate asymmetries (van Fraassen 1989, 239-243). In particular, is the difficulty of reconciling the equations that are intended to describe the behavior of physical entities with the behaviors of observed phenomenon. In other words, it is not clear that we can reconcile the equations, which are themselves taken to be time-reversal-invariant, with the observed phenomena that appear to provide evidence for natural asymmetries.<sup>135</sup>

The issue is that some additional explanation is needed to account for why there are apparent asymmetries in nature if at the fundamental level, as described physics, nature is symmetrical.<sup>136</sup> This is an unresolved issue for those who concern themselves with the issue of symmetry breaking (Close 2000). For this reason, it would appear that the claim that we should understand reality as being fundamentally symmetrical has not yet been substantiated—or at

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<sup>135</sup> This is also understood as the issue of the *anisotropy of time* in (van Fraassen 1970, 86).

<sup>136</sup> Although in earlier chapters I provide reasons for dismissing the idea that there are fundamental structures, I am arguing in the current section that *if* there is a foundational structure and that structure turns out to be modal, then we should still not think of that structure as being symmetrical.

least not dismiss the view that asymmetries can only produce other asymmetries. These points indicate that further discussion is needed to develop an account for how symmetries on their own are sufficient to account for asymmetries, including asymmetrical dependencies such as those found in modal structures.

Third, without a readily available account of how symmetries can produce asymmetries, the above discussion provides support for thinking that the ontic structural realist will need to appeal to something in addition to symmetries to account for modal relations. This is consistent with French's own claim that "the ontology we should 'read off' our physics should be one of laws and symmetries" (French 2014, 64). Shortly after that passage, French provides insight to what it is about laws that allow them to contribute to the modal structure beyond what symmetries alone can provide. He writes, "The laws characterize relations between properties, the identity of which is given by their nomic role" (French 2014, 64).

Understanding laws in terms of relations among properties may tempt us to interpret French as endorsing a Humean account of laws. On the standard Humean view, objects exemplify properties. To understand the relations of those properties, then, requires identifying the objects that exemplify those properties in such a way that permits them to stand in nomic relations to one another. This maneuver, however, is not allowed to the ontic structural realist who advocates dismissal of an object-based ontology. In fact, French explicitly states that the ontic structural realist should not adopt a Humean account of laws since doing so commits one to an ontology at odds with ontic structural realism (French 2014, 235).

The rejection of a Humean account of laws indicates that ontic structural realists would not endorse a reductionist account of laws. We might think, then, that ontic structural realists

would be more friendly towards nonreductionist accounts of the sort mentioned in the survey I provide at the beginning of this chapter. This, however, is not the case.

Ontic structural realists explicitly dismiss the idea that laws govern in the way that the DTA account of laws recommend, since that form of governance requires something independent of nature to govern (Cei and French 2014, 27). French also rejects an account of dispositions that neo-Aristotelians develop (French 2014, 262), therefore, not wanting to endorse the account of nonreductive laws of the kind that Bird develops. The lesson here is that both DTA and dispositional accounts take ontic structural realism too far afield from a naturalistically informed metaphysics, which would run ontic structural realism into the kinds of underdetermination problems that the ontic structural realist aims to avoid.<sup>137</sup>

A lingering possibility is that we leave laws of nature as primitive features of the world's structure, as was done with earlier treatments of modality. Given substantive criticisms of the idea that there are laws, a metaphysics that includes laws is on the defense. Furthermore, since French treats laws as being "read off" our physics it is more than armchair speculation that such laws are taken to exist. For these reasons, it seems that the ontic structural realist will not provide a convincing case to those who are not already sympathetic to her project if lawhood remains a primitive concept. Although it is unlikely that we can provide a complete definition of laws, since a complete definition can be given for hardly any concept, we can provide some details of what is involved in laws by observing their function in the ontic structural realist's ontology.

Partly the difficulty in understanding the ontic structural realist's account of laws is the persistent attempt to assimilate it to previous accounts of laws. These accounts, however, are framed in terms of object-based ontologies: the DTA account understands laws in terms of

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<sup>137</sup> This problem was addressed in the previous chapter.

second-order relations of universals that govern the objects that are instances of those universals; dispositionalists understand laws as being dependent upon essential properties of objects; and Humeans reduce laws to the discrete features that comprise the Humean mosaic. The shift away from an object-based ontology requires that the ontic structural realist account of laws cannot be developed in the same fashion as those accounts of laws that arise from an object-based ontology. Instead, I maintain that not only can the ontic structural realist adopt a process framework (as I argue in the previous chapter), but that the ontic structural realist should do so for the purposes of developing a coherent account of laws.

First, if we agree with Ladyman and Ross that there may be structural facts about the whole universe, and such facts constrain facts about particular regions of the universe (Ladyman and Ross 2007, 288), and if we also understand structures in terms of metastable processes, then we can begin sketching an account of laws in terms of those processes. This allows us to understand those laws and symmetries that are “read off” from the physics to be characterizations of the general metastable processes that physics takes itself to describe. Second, the property relations that are taken to be characterizations of the laws are themselves metastable configurations—susceptible to the type of relations that they enter into. Third, laws have the task of *encoding* “the relevant range of physical possibilities, the structure of which they are features can be said to be modally informed” (French 2014, 64). To encode, is to transmit, in this case, modal information. More specifically, the encoding is the description of a causal process that allows information to flow “along asymmetrical gradients” (Ladyman and Ross 2007, 289).

Understanding the laws of nature as themselves causal processes capable of encoding the global structures allows the ontic structural realist to then account for the delicate balance between symmetries, laws, and putative objects. In particular, both physics and mathematical

symmetries exemplify metastable configurations. In the case of mathematical symmetries, we can understand them as idealized group-theoretic abstractions that contribute to our general understanding of the aspects of the world that the abstractions are taken to describe. In the case of physical symmetries, any physical system exists in relation to some other system—in which case, a system that exhibits the appropriate proportions for it to be symmetrical is in a metastable configuration with its surrounding environment. If we take for granted the idea that there are genuine symmetries, then we can understand laws as those causal processes that those symmetries enter into such that the modal feature of the structure is realized by those metastable processes we identify and treat as being objects.<sup>138</sup>

Without allowing for this process framework to inform the ontic structural realist's account of laws, French, Ladyman, Ross, and Barenstain are left with difficult problems. First, they are left with how modal relations are capable of being generated by symmetries without stating that laws are simply the missing piece. Second, they have the further difficult task of explaining how putative objects, which we take as evidence of there being asymmetries, are themselves not the appropriate expressions of lawlike relations. Third, Ladyman and Ross especially have the difficulty of accounting for how causation enters into the structure of the world. Their current position only allows them to say that they are not satisfied with Russell's objections (Ladyman and Ross 2007, 266).

The process framework helps the ontic structural realist overcome these difficulties since processes are themselves inherently dynamic. Given the fundamental dynamicity of processes, there is no need to consider how a fundamental symmetry can generate asymmetries—instead

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<sup>138</sup> This is consistent with Ladyman and Ross' own denial of individuals when they write "we precisely do *not* want to take the existence of individuals for granted, since we hold them to be only epistemological bookkeeping devices" (Ladyman and Ross 2007, 240; emphasis in original).

the asymmetries are understood as being primary and the symmetries are seen as being metastable configurations of those asymmetrical processes. This view also has the benefit of understanding how asymmetrical processes are able to reach equilibrium states and can be broken without having to account for symmetry breaking. The second difficulty is also able to be overcome since putative objects are capable of being given a processual interpretation—we can then understand how these processes exhibit metastable conditions that then allow them to exemplify the appropriate nomic relations. Last, because the fundamental processes are themselves dynamic, they are inherently causal. For this reason, if anything, it is causal efficacy that is being taken for granted—but it is the causal structure that allows us to better understand how the modal structure can be imparted to more general structures by those processes that we can identify as being lawlike.

### 7.3 A Programmatic Conclusion

Whereas earlier chapters argue that a process metaphysics is consistent with ontic structural realism, this chapter has gone further in sketching how the adoption of a process framework can offer additional justification for an ontic structural realist's account of laws. This, however, has *only* been a sketch. The motivation for discussing ontic structural realism at all results from observing a gap in the literature on laws. Since debates on the relationship between ontic structural realism and laws have only just begun, the discussion here provides additional insights to how the debates on processes, structures, and laws can be carried forward.

I have focused on how the adoption of a process metaphysics can be reconciled with ontic structural realism. The completion of this project would require an explicit defense of ontic structural realism, which I have not given. In addition to developing a defense of ontic structural realism, future tasks include showing that in maintaining realist commitments to modal and

causal relations, the ontic structural realist must also maintain a realist commitment to laws. This commitment is a result of lawhood, cause, and modality being interrelated concepts. At best, these realist commitments appear to only have been stipulated by ontic structural realists. More needs to be said regarding how the conjunction of laws and symmetries allows for modal and causal relations. In particular, more details are needed to provide an account of how asymmetrical relations, of which both modal and causal relations are instances, can arise from symmetries, convincing to those who are not already sympathetic to the ontic structural realist's cause. As I have indicated, since a process framework and ontic structural realism are consistent with one another, and ontic structural realism is fundamentally at odds with a substance ontology, ontic structural realists will need to adopt a process framework to account for asymmetries.

Although I have not offered a definitive argument detailing how the integration of a process framework allows the ontic structural realist to account for asymmetries, understanding structures in terms of metastable processes provides some insight into how symmetries might result from asymmetries—rather than the reverse. The adoption of this framework, in addition to laws, then, indicates that the ontic structural realist can provide an account of modal relations instead of simply stipulating them. Such an account needs to be given since the incorporation of modal relations distinguishes ontic structural realism from structural empiricism. I have gestured at how the ontic structural realist can accommodate these difficulties by integrating a process framework, the adoption of which can account for modal relations. Furthermore, the incorporation of metastable processes, which are dynamic, offers some explanation for the existence of objects that are tracked by the special sciences. Last, the incorporation of such a framework, along with laws, is likely to assist us in better accounting for causal asymmetries,

which may include information flow. Such developments, then, assist us in developing a coherent understanding of the world in general.

This dissertation has thus shed light on some of the refinements needed to our metaphysics when we incorporate naturalistic considerations, while also motivating the development of a revised framework with which to better understand laws, causes, and modality. The further development of these points would indicate that not only *can* ontic structural realism adopt a process metaphysics, but, more importantly, that it *should*.



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