The Critical Stance:
Ernst Cassirer and the Realist–Empiricist Dispute in the Philosophy of Science

by

David Brooke Struck

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ABSTRACT

THE CRITICAL STANCE: ERNST CASSIRER AND THE REALIST–EMPIRICIST DISPUTE IN THE PHILOSOPHY OF SCIENCE

David Brooke Struck
University of Guelph, 2015

Supervisor:
Dr. Jeff Mitscherling

In the contemporary philosophy of science, the champions of the realist–empiricist dispute are structural realism and constructive empiricism, respectively. In establishing their historical lineage, structural realists point to the work of Ernst Cassirer. In this dissertation, I argue that Cassirer cannot be pressed into service to their cause; while some of his conclusions about science seem *prima facie* in line with structure realism, any such agreement is merely apparent. Digging into Cassirer's philosophy of science, and situating that work within his broader project of the philosophy of symbolic forms, it becomes clear that his arguments instead present an important challenge to the structural realist camp. In fact, his arguments against abstraction and epistemic foundationalism speak against any assumption of a mind-independent world, undermining the contemporary realist–empiricist dispute *in toto*. In place of the doctrines of realism and empiricism, Cassirer offers us the system of the symbolic forms. In place of the empirical and metaphysical stances, I develop on Cassirer's behalf the critical stance, drawing on Cassirer's appreciation of Kantian transcendentalism and Hegelian dialecticism.

DEDICATION

In memoriam RS et BDB.

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The present work demanded the greatest focus, attention and creativity I could muster, and I am greatly indebted to those around me for their support during these years, without which this work would not have been possible. I would like to acknowledge some of those contributions here, cognizant that such brief mention is wholly disproportionate to the contributions themselves.

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At all times, I have benefitted greatly by being immersed in an intellectually vibrant milieu, constantly inspiring me to press on and ask more questions. The philosophy of science reading group at the University of Guelph provided me with many opportunities to test out new ideas and explore the work of others, while enjoying myself immensely. It is on account of Peter Loptson that I first began to read Cassirer, whose work has stirred my thoughts profoundly.

Given the importance of science to the present work, the input of several scientists has proven crucial. Dr. Richard Frank, Dr. Benjamin de Jourdan, and Mr. Kristoffer Dalhoff (soon to be a doctor in his own right) provided me with important insights about the biological and chemical sciences. My thoughts about contemporary physics have been greatly influenced by my dear friend Mr. Orad Reshef, also well on his way to the doctoral moniker.

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CONTENTS

INTRODUCTION

The war between realism and conventionalism bitterly rages ever strong. We find early skirmishes in Plato's *Cratylus*, in which Socrates examines and demonstrates the problems with both of these views of language; and the contemporary realist–empiricist debates in the philosophy of science carry on that same traditional feud. The feud in both of these cases, and many historical links in between, is the same: do humankind's concepts pick out the real furniture of the world, or not? This discussion is of course only one facet of a broader dialogue that concerns the very relationship between mind and world, and what I would like to do in this dissertation is call to our attention (and challenge) a particular presupposition that underlies both realism and conventionalism, in the hopes that we might make some headway in the debate between those two rivals, both alike in dignity. Of course, to assume that I might settle the issue once and for all would be a very bold move indeed, and so for those who fancy boldness, I invite you to take up the charge that I will begin (or, as you will see, continue) in the following chapters. For those who prefer more of a restrained approach, please consider these remarks not as intending to settle the dilemma, but rather to offer a third option few give much attention these days.

In the *Cratylus*, Socrates' picture of realism is one that relies heavily on etymology. Briefly put, the belief was that the original act of naming got something fundamentally right about the world's make up. Accordingly, if we wish to assure ourselves that we are referring successfully and not merely appealing to phantasms, what we must do is trace our words back to those original acts of naming: the etymological history, from that true act of naming to our current usage, acts as the guarantor that our present usage is veridical. But that's a picture about realism in the realm of language. What seems to carry greater weight and potential interest these days is not our natural languages, but our natural science, and so my exploration in this thesis will focus on (modern, Western, natural) science specifically, as opposed to realism with respect to language or with respect to any other conceptual framework, or even realism in general.

There is an interesting contrast to be noted between linguistic realism as Socrates portrays it and scientific realism as we encounter it in a modern context, and that has to do with *when* our concepts "get things right." In Socrates' discussion, it was the original acts of naming that picked out the true furniture of the world, and to those original acts that we appeal in tracing an etymological heritage. By contrast, modern science seems to rest on the idea that we are not getting further and further from the true picture of the world (if one is a realist), but rather that we are getting closer and closer to the truth as science develops. Whereas the ideal of natural languages, their most veridical form, is placed at the outset of history in the *Cratylus*, the ideal of science is placed at its conclusion, sometimes referred to as "final science" or "the end of science," and it is to this final scientific account of the world that we should be appealing to show that our present concepts are mapping the world's furniture correctly (again, if one is a realist).

In his final work, *The Myth of the State*, published posthumously in 1946, Ernst Cassirer explores this same dichotomy in human history: are we progressing towards an ideal state to be found at history's end, as the German Enlightenment thinkers believed; or are we heading further and further from the cultural taproot and source of legitimacy to be found at humankind's outset in myth, as the Romantics believed? Ultimately, Cassirer rejects both of these poles as insufficient. The idea that history completely defines us as human subjects, just as the idea that history is nothing more than instructive material that we may or may not take up in working towards a better future, are both terribly inadequate. We are not completely at the mercy of history, nor are we completely independent of it and free to take it up as/if we please; we exist in a co-constituting relationship with it. To believe that either the self or its history completely dominates the other is to take a stultified view of one of the two, whereas in fact they exist in a dialogical relationship. To stultify and solidify either the subject or its object is to open an unbridgeable gap, which in the realm of history swallows up human freedom entirely.

Why do I bring all of this up? In a dissertation about the realism–empiricism debate in contemporary philosophy of science, what relevance could this talk of history's ideal possibly have? I see the following parallel: the notion that science "gets it right," i.e.: picks out the real furniture of the world, at its endpoint is analogous to the Enlightenment idea that history reaches perfection at its conclusion. Cassirer argues against that very dichotomy itself, concluding that only a stultified view of subject and/or object could lead one to think that past, present and future are dissociable in the kind of way that is necessary if one is to postulate an ideal at either terminus. In science as in history, we should think long and hard about that presupposed stultification, and I will offer an alternative that overcomes the dichotomy as a whole. In the realm of history, Cassirer argues against the dichotomy of an ideal at beginning or end, and the stultified notions of subject and object that are embedded therein; in the context of science, I shall argue against the very dichotomy that science either "gets it right" or does not, again elucidating the problems of a stultified subject and/or object.

Put quite crudely, I will argue against taking up any position along the realist–empiricist spectrum in science, showing that the whole spectrum assumes that the world, the topic of natural science, is independent of the experiencing and experimenting subject. This is an assumption that we need not and should not grant, and I will draw heavily on Cassirer's work, in both arguing against that assumption and presenting an alternative conception of the subject–world relationship, specifically as it pertains to science. In a broader context, I hope that this indictment of the realist–empiricist spectrum in the realm of science can serve as a model of the sort of indictment that we ought to bring to the realist–empiricist spectrum in general, regardless of the arena in which it appears.

What do we stand to gain from this examination in a broader-than-academic context? There are two interrelated problems that seem to me to be prevalent in our contemporary society, and I believe that they rely on a misunderstanding of the subject–world relationship. Those problems are scientism and (cultural) relativism, which I bring

together under the heading of naturalism.[1] Scientism is the belief that science has all the answers, or at least the answers to all the questions that matter (or, perhaps, to all the questions that can be answered). Science provides objective answers to which we all must pay deference, or so goes the naturalist conception of the world. It consequently comes as no surprise that we find astrologers, for example, claiming to be scientific, lest they not be taken seriously. By contrast, beyond the province of science we find only subjective truths, where "subjective" takes on the most pejorative of senses. If we are not being scientific, then we are merely wandering in the province of opinions. There are not right answers, full stop; there are only right answers for you and right answers for me, and there is not even a point in discussing these positions rationally, as we simply do not agree and there is no fact of the matter that could settle the issue, that could show one of us to be right and the other wrong. This is how I understand naturalism.

In his *Malaise of Modernity*, Charles Taylor addresses the vicious relativism that we find in today's society, showing the philosophical problems and troubling real-world outcomes that result from cultural relativism of this kind. There are also significant problems that arise from our society's overall gross ignorance of the nature of science: misunderstanding the process of scientific theorization and overestimating the reliability of scientific results, which are often tenuous and circumstantial, has overwhelming impacts on the lives of individuals when citizens are asked to consider forensic evidence in legal trials. Misunderstanding the scientific process leads citizens and politicians alike to ask questions of environmental scientists that simply cannot be answered, because the citizenry and politicians who manage them are looking for conclusive answers about categories that fit into a world picture quite different from that of the scientist. (And the multiple stages of intermediary contact between scientists and citizens do nothing to help the failures of communication between these two sides. We need to put them in closer contact, not keep them apart as the present Federal government seems to think beneficial, but I digress.) These are just a couple of examples of what's at stake in clarifying the nature of scientific inquiry and its relation to the world.

The present dissertation is an attempt to address the relationship between subject and world as it relates to science, which I see underlying scientism, one facet of the naturalist position. How will this endeavour be carried out? The first step in crafting my argument will be to lay out a broad conception of the realist–empiricist dichotomy as it appears in contemporary philosophy of science. I must here navigate between Scylla and Charybdis: the characterization must be general enough not to apply only to very specific flavours found at either pole, but must be specific enough so as not to be entirely vacuous. Furthermore, while I will be discussing the dichotomy specifically as it applies to science, I would like to stress that the criticisms and remarks are meant to apply to realist–empiricist debates well beyond that specific sphere.

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[1] For those of a more scholastic persuasion, I am here following the methodological sense of naturalism, following Jaegwon Kim. Bas van Fraassen discusses similar ideas under the heading of "secularism."

Given a characterization of realism and empiricism, and a few arrows that each camp likes to loose at the other in order to motivate their own side, I will then move on to explore a quite contemporary position in the debate: structural (scientific) realism. The structural realist camp is one that set itself up officially in 1989 with John Worrall's essay "The Best of Both Worlds." Since then, the position has garnered a good bit of attention in the literature of Anglo-American philosophy of science; its main proponents these days, each for different reasons, are James Ladyman, Steven French, and Don Ross. I introduce this position for two reasons. First, because it attempts to navigate something of a middle way; it is a form of "restricted realism," as Barry Gower calls it. The literature on structural realism engages quite substantially with the arguments for both realism and empiricism, and therefore offers a nice avenue to fleshing out some of those ideas.

A second (and more important) reason for introducing structural realism, in addition to further elucidating the realist–empiricist dichotomy, is to use it as a transition into the philosophy of Ernst Cassirer. It affords the opportunity for that transition because the structural realists see in Cassirer an ally to their structuralist cause. To align Cassirer with structural realism, however, would be a shallow and inappropriate reading of Cassirer's work. Though some of his conclusions about science can often sound like they endorse a position similar to structural realism, I will show that Cassirer's philosophy of science, especially when situated within his broader project of the philosophy of symbolic forms, makes any kinship with structural realism impossible. Furthermore, I will argue that to cherry-pick these apparently attractive conclusions is also impossible, as Cassirer's arguments for those conclusions completely undermine the foundations of structural realism. Structural realism offers an ideal opportunity to introduce the work of Cassirer into the realist–empiricist debate in the philosophy of science, and hopefully contrasting my reading of his work with those of Gower and others will allow a clearer picture of Cassirer's philosophy to emerge.

Once I have elaborated the structural realist position, as well as their reading of Cassirer, I will offer a comprehensive interpretation of Cassirer's work, one that delves deeper than the surface of his philosophy of science and into the philosophy of symbolic forms, and I will thereby call into question the stultified notions of subject and world that underlie the realist–empiricist debate as a whole. His work criticizes this presupposition, offering an alternative position that I will explore in some detail. My intention is thereby not only to re-emphasize some criticisms of the scientific realist–empiricist debate that Cassirer himself makes, but also to present an alternative, offering a way out of this dichotomy in the realm of science and hinting at such an escape in other areas where the dichotomy is found. To treat all of those areas at once would be impossibly ambitious, at least if I hoped to do so in any detail. So, to finally begin what will surely be a long journey, let us characterize the realist–empiricist dichotomy in contemporary philosophy of science.

CHAPTER ONE

As I stressed in the introduction, to attempt to catalogue the entire realist–empiricist dichotomy would be a ludicrous and unachievable endeavour. The same may be true of the dichotomy even just in the realm of science. So I am faced at the outset with a position similar to the one in which Descartes found himself at the opening of his famous *Méditations*: to enumerate and examine each position under the umbrella of this dichotomy is impossible, so I'll attempt to find a tie that binds them all together and cut that instead. With luck, that common thread will be central enough to hold together a suitably broad swath of cloth, and the cutting of it will be effective. Let us find this common thread through a historical recap of recent empiricism.

The main motivation for this admittedly caricatured history is to get a sense of the essence of empiricism, what it is that makes a certain position empiricist. I will therefore elide over some specific details about how different types of empiricism are differentiated from one another. However, I will return at the end of the chapter to digest this caricature, at least partially: I will point out a few parameters over which I elide in the body of the chapter, and indicate some different ways in which the values for those parameters have been set, so that hopefully some more specific empiricist positions can become recognizably encompassed by my caricature. For the time being, please allow me to introduce the broad strokes of empiricism in this caricatured fashion, so as to establish the essential points that I'll need when I later return to the realist–empiricist debate with Cassirer's arguments in hand.

Recall that I ultimately will not argue against any particular type of empiricism, but against empiricism generally, so even if these elided details don't do full justice to a given empiricist position, if the essence of empiricism characterizes it, then the argument should still hold. And if some positions within the empiricist tradition escape my broad strokes, well then I shall have to satisfy myself with having not completely addressed every position. But this is likely to be true of any history one would trace, no matter how caricatured. So, without further ado, back to the history itself!

§1.1 Logical empiricism

In the late 19th and early 20th centuries, in the wake of Kantianism and Hegelianism, we find a certain reticence to engage in metaphysics. Much of what had once been considered the domain of philosophy was being parceled out and outsourced into independent disciplines, and some philosophers worried that they were being left behind. The old traditions of metaphysics did not seem to be producing anything near the power of the empirical sciences, which were experiencing something of a heyday, and some felt that if philosophy didn't adapt its methodology to the times, then it would soon be outdated and have nothing left to properly call its own. Our sentimental attachment to the metaphysical speculation of the *bons vieux temps* had to be given up, replaced with the rigourous methodological structures of the natural sciences if we were to have any hope of making progress. Or so was the belief of the logical empiricists.

Logical empiricism might be characterized as an attempt to render philosophical investigation scientific; that is to say, to put philosophical investigation onto a continuum with scientific investigation by adopting the formalized methods of the latter. The result is a philosophical style that draws heavily on formalized, axiomatized systems of logic and mathematics. It was believed that this kind of formalism was the avenue to truth, and that whatever resisted formalization did so because it lacked veracity. In short, non-formalizable language was merely language games, in the most pejorative sense. And any problems that arose in such language demonstrated the ability of language to lead us astray, which one could resist through the insistence on formalization.[1]

But not everyone followed the logical empiricists in the belief that formalization of this kind would lead to philosophically fruitful conclusions. A famous historical case of this is the dispute between Carnap and Heidegger about the latter's claim, "*Das Nichts nichtet*,"[2] for which Carnap criticized Heidegger because "nothing," in formal logic, is the negation of the existential quantifier rather than itself an object (and therefore could not carry out action, as Heidegger has it do in his famous sentence). To accept Heidegger's phrase, then, is to controvert the rules of formal logic, and the sentence must therefore be meaningless. So much the worse for logic that it is limited in this way, was Heidegger's response.

And that really emphasizes the heart of the disagreement: when logic and natural language are at loggerheads, which one is at fault? According to logical empiricists (of which Carnap was one), logic wins out and language is speaking nonsense. According to Heidegger—and, if you take Michael Friedman's line as presented in *A Parting of the Ways* (2000), the entire tradition of Continental philosophy that followed after Heidegger—the fact that language can be meaningful in a way that logic cannot express

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[1] It might be more fair to say that this is a characterization of logical positivism. No principled boundary exists to separate logical positivism from logical empiricism. However, it's correct to say that logical positivism is the earlier phase of the movement, or that it is the earlier movement, if one insists upon separating them. For the purpose of keeping this discussion tidy, please note that I will treat these two as phases of a single movement, and stick with the name "logical empiricism" throughout to maintain consistency in terminology.

[2] "The Nothing nothings," is the nearest translation. Or, "The Nothing noths." Usually only one of these translations would be offered, but I feel that neither alone is sufficient to fully convey what Heidegger is doing here. The former is insufficient because "nothings" can be understood as a noun (i.e.: "several nothings"), but in fact Heidegger uses it as a verb. The latter translation conveys this active sense better, because "noths" isn't a nominal form of any word; but "to noth" does not exist in our lexicon, and so the while the active sense of the word is conserved, the content is lost. In short, either of these translations on its own would only be understandable by people who know the meaning already (either because they know the quote, or because they speak German), and that completely defeats the purpose of offering a clarificatory translation.

shows the limitations of formal logic, and therefore the inadequacy of conceiving of philosophical investigation as part of the scientific enterprise.[3]

The logical empiricist abstention from metaphysics, in the realm of science, took the following form: logical empiricism denies any commitment to the unobservable content of scientific theories; they deny that such content is objectively real. But of course scientific theories include all kinds of language that would appear to commit us to unobservables, such as discourse about quanta of diverse flavours, so the logical empiricist solution was to propose that we must interpret such language non-literally. Rather, they claimed, language about unobservables is simply a shorthand way of referring to the observable world (van Fraassen 1980, 10; Chakravarrty 2007, 10). Given the appropriate translation rules, we can go on happily using scientific language in a non-literal fashion and never commit ourselves to the thorny unobservables that get us all wrapped up in the tendrils of metaphysics.

Logical empiricism is an antirealist position in that it rejects commitment to the objective reality of (1) unobservable entities and (2) modalities other than the actual.[4] There are just real, observable facts, [5] and we use our languages of logic, mathematics, and scientific theories to systematize those facts. The facts are not in themselves interconnected,[6] except by our systematizing languages, the value of which is judged solely on their empirical adequacy. The highest commendation of a systematizing language would be that it takes account of all the evidence and makes accurate predictions. Past, present and future observations exhaust the realm of the actual, and so to take full account of them is the goal of systematization.[7]

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[3] For further details about this dispute, see (Heidegger 1929; Carnap 1932; Friedman 2000).

[4] Philosophers generally use "modality" to refer to necessity, contingency, possibility, impossibility, counterfactuals, etc. However, it often gets overlooked in this practice that actuality is itself a mode as well.

[5] Of course, how we define what is "observable" is no straightforward matter, and differences in approach here delineate different positions within the logical empiricist camp. For example, observability might be defined at the level of whole sentences, individual terms within a sentence, or entire theories. See (Hempel 1965b) for a discussion of some such positions; it also nicely illustrates the commitment to a logically rigorous methodology, characteristic of logical empiricism. On the topic of logical positivism developing into logical empiricism, it may be said that the latter was a softening of previous attitudes about the need for a rigid criterion of meaningfulness. This softening came about after repeated attempts to give a fully articulated criterion of meaningfulness encountered serious problems, time after time.

[6] Hume's ghost haunts empiricism in non-trivial ways, and these commitments only to the actual, and attempts to exorcise modality through systematization, are proof thereof.

[7] Creath (2011) notes that logical empiricists did not have an agreed-upon set of shared doctrine; even empiricism was not a topic on which they could agree. I'm following van Fraassen's characterization of empiricism here (1980, 3), and taking for granted that logical empiricism is a subset of that broader term. Though one or more position worthy

Before moving on, I believe that I should say a thing or two about what unobservable entities are. Anjan Chakravartty, in his *Metaphysics for Scientific Realism* (2007, 3–4), offers a very clean and tidy summing up. The first dichotomy he makes is between observables and unobservables, where the former are anything that we could in principle observe with our unaided senses if we were suitably located spatiotemporally. So dinosaurs are observables: even though none of us did observe them, if we had been around in the appropriate era, then all we would have had to do is look, and there they'd have been. (And then we'd flee frantically to record our observations, like good scientists, and maybe even to save our lives.) By contrast, no matter when or where a human being was/is/would be, she could not have seen[8] an electron with unaided senses, and so electrons are unobservables.

Unobservables get broken down into two categories too: detectable and undetectable. Though an electron could never be seen directly with the naked eye, we can certainly detect one (assuming for a moment here that such things exist) using certain tools and techniques. For example, we can fire an electron through a cloud chamber and track its path by its cloudy tail. We aren't seeing the electron *per se*, but we are detecting it indirectly through an "augmentation" of our senses, so it gets classified as a detectable unobservable. By contrast, whether mathematical objects exist or not could never be experimentally verified, as they are "entities… that are neither observable nor detectable, but whose existence one posits for theoretical or explanatory reasons" (Chakravartty 2007, 15). I find this example not overly helpful as a clarification, and so I will venture a speculation that God might get classified as an undetectable: we have no way of predicting, with any empirical exactitude or precision, how God would act in certain circumstances, and so no empirical results can act as detectors for His presence. He is therefore undetectable (by empirical means, and those are the ones at issue here). With this taxonomy of observables/unobservables and detectables/undetectables, let us return to the historical exploration of empiricism.

Why aren't we all logical empiricists? Simply put, because the notion that the problems of metaphysics and the problems of philosophy of science can be reduced to problems of language, and thereby expunged by the strictest formalization, is wrong (van Fraassen 1980, 14). If one is going to posit that language about unobservables can be translated

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of the logical empiricist moniker, perhaps even the reader's own preferred position, might be left out by this decision, I would urge the reader to press on in spite of it and be mindful of which parts of my fledgling argument might still apply.

[8] Chakravartty himself notes that the term "observables" seems overly optocentric. Optocentrism is a problem in much of the literature on observation, to be sure, and my examples here are no exception. However, I don't think that the term "observe" implicates vision specifically: I think that smelling a cake is an observation, as is hearing a bird's song. He's right to point out that optocentrism is a persistent problem in this literature, and I would like to echo that point here. I'm not sure, however, that the term "observation" is really quite as culpable as he makes it out to be, though obviously far less hangs on that.

into language about observables (or, worse, actual observations), then one is committed to the possibility of a language that is strictly about observables (or observations). Despite great efforts and painstaking logical gymnastics, such a language failed to materialize, and "insuperable difficulties with this semantics led ultimately (in large measure) to the demise of logical empiricism and the growth of realism" (Chakravartty 2011, §4.1).

§1.2 Scientific explanation

The gradual downfall of logical empiricism went along with a gradual decline in the aversion to metaphysics, and thereby a new wave of exploring versions of realism.[9] It might be helpful at this juncture to explore a case study of this transition in order to get a better feel for how it proceeded and what was at stake. Let us examine, then, the discussions of scientific explanation. We won't start all the way back at Aristotle, who discussed explanation by deduction in his *Posterior Analytics*, but one could go so far back if one wished. Instead, let us begin with a more contemporary moment. In the anti-metaphysical days of the late 19th century, Pierre Duhem (and many others) divided description from explanation, and proposed that explanation was the territory of metaphysics. Science gives only precise, accurate, and helpful descriptions; but explanation is beyond its ken and requires metaphysical speculations that run contrary to science itself, because these speculations cannot be tested empirically.

The association of explanation with speculative metaphysics held on tight for decades. But all that changed in 1948 with the publication of Hempel and Oppenheim's "Studies in the Logic of Explanation." Because the now-infamous deductive-nomological (D-N) model of explanation appealed to logical structure rather than to spooky metaphysics, it reopened the possibility of being an empiricist while at the same time rescuing explanatory power for the sciences. Cake was never both had and eaten with such delight. And all because the D-N model pitches explanation in terms of a logical relationship between sentences rather than a thick metaphysical connection in the world.

Let us briefly recapitulate the theory. According to Hempel, scientific explanations are arguments. The conclusion of the argument is a sentence that describes the phenomenon in question, the *explanandum* phenomenon. "The *explanandum* phenomenon in a deductive-nomological explanation may be an event occurring at a particular place and time…. Or it may be some regularity found in nature, … or a uniformity expressed by an empirical law" (Hempel 1966, 51). The premises of the argument are jointly called the

[9] (van Fraassen 2002, xviii; Chakravarrty 2011, §4.1). That is not to say, of course, that there ceased to be empiricists, nor that there were no further empiricist developments during this time—as we shall see later on. In fact, I don't even want to claim that empiricism ceased to be mainstream in the philosophy of science in general. Specifically, I aim to illustrate that within the epistemology of science, in particular, there was a greater exploration of realist options than had previously been the case when anti-metaphysics was at its apex.

explanans. Hempel stipulates four conditions that must be met in order for the *explanandum* to be explained:[10]

1. The *explanandum* must follow logically (i.e.: deductively) from the *explanans*.
2. The *explanans* must contain one or more general, scientific laws.
3. The *explanans* must contain empirical content, sometimes called "antecedent conditions."
4. The sentences in the *explanans* must be true.

Taken together, these conditions amount to stipulating that any scientific explanation will be a sound argument, where the initial conditions are subsumed under the general law from which we derive the *explanandum*. We have a major and a minor premise, both empirical and both true, and the *explanandum* follows from them deductively. "[T]he question '*Why* does the phenomenon occur?' is construed as meaning 'according to what general laws, and by virtue of what antecedent conditions does the phenomenon occur?'" (Hempel 1965, 246).

Let us illustrate this with an example, for the sake of clarity. Suppose that we run an electric current through a penny by connecting the terminals of a battery across it. The penny is made of copper and the battery has a non-zero voltage. These are antecedent conditions. Copper is a conductive material, meaning that if a voltage is connected across it then a current will run through it. That is our general law. Here is the explanatory argument presented formally:

The terminals of the battery are connected to the penny.
The battery has a non-zero voltage.
The penny is made of copper.
Copper is a conductive substance.
Therefore, electric current runs through the penny.

The first four statements constitute the *explanans*, and contain both empirical content and general laws, thereby satisfying conditions 2 and 3 above. They are also true, satisfying 4. And the fifth sentence, the *explanandum*, follows deductively from the *explanans*, satisfying condition 1. Success! We've explained the phenomenon in question.

There are three types of objections to the D-N model that I would like to treat here, as I think that they'll help us to understand the historical significance of Hempel's account as it pertains to the issue of the return to metaphysics: tacking, asymmetry, and law-likeness. The issue of tacking is as follows: if we take a deductively sound argument, we can add superfluous information to it without disrupting its soundness (so long as the added information does not contradict any elements of the original argument). As a result, going back to the example of the copper penny outlined above, we can derive the flow of

[10] Note here that I am only treating Hempel's D-N model, though he also presented deductive-statistical (D-S) and inductive-statistical (I-S) models. Following Salmon (1989), I consider D-S explanations as a subset of D-N, and therefore all of my comments about D-N are meant to apply equally to D-S. I-S is an altogether different and thorny issue that I will not treat here. Problems with I-S might also prove instructive in narrating a return to realism in scientific explanation, but I believe that I can draw the lessons that I'm after by treating D-N alone, without bolstering my claims by also treating I-S.

current through the penny from a law about the conductivity of copper and a law about the conductivity of gold, even though gold is not mentioned in any of the other premises. That is to say, we could add the following premise to the explanatory argument: "Gold is a conductive substance." But that is absurd! Surely the conducting of electricity by this penny has nothing to do with the conductivity of gold or of any other substance.[11] So how can we eliminate this information that has been tacked onto an otherwise viable explanation? One option is to say that only premises necessary to the deduction can figure into the *explanans*.

But the tacking problem can be thornier than that. Perhaps instead of tacking on the law about the conductivity of gold as an additional premise, we could tack it onto the law about the conductivity of copper. That is to say, replace the fourth premise above with the following: "Copper and gold are both conductive substances." The problem that arises here, for the logical empiricists, is that we need a formalized way to divide one law from another that is artificially tacked onto it. We recognize intuitively, just using our powers of natural language, that this sentence is simply a throwing together of laws, but we lack the formalized tool to express why. So much the worse for logic, one might say, following Heidegger.

Another set of cases that proved especially troubling is known as asymmetry cases, which arise because we can appeal to equations or ratios to explain any of the values that figure in them. In asymmetry cases, we appeal to values that seem intuitively not to be explanatory, but the D-N model has no way of excluding them as viable explanations. For example, we can appeal to the height of a flagpole, the angle of the sun and laws about the propagation of light in order to explain the length of the flagpole's shadow. We can also appeal to the length of the shadow, the angle of the sun and those same laws to explain the height of the flagpole. But while explaining the length of the shadow by the height of the flagpole intuitively seems fine, explaining the height of the flagpole by the length of its shadow seems backwards. After all, the flagpole is not of that height *because* of the length of its shadow;[12] the length of its shadow is not *why* the flagpole has that height. Even the fact that we talk about the flagpole's shadow and not the shadow's flagpole discloses the fact that we conceive of this relationship as asymmetrical. But the symmetry of the D-N model does not allow us to take this into account.

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[11] Actually, the conducting of electricity by this penny surely *does* have to do with the conductivity of gold and other substances, because the chemical explanation for conductivity will take the same form for all substances. This problem just shows the pseudo-issues that can arise when we discuss scientific explanation by appealing to explanations that no scientist would accept as exemplary, but I'd be opening a can of worms to start discussing the relationship between science and the community of scientists here, or the relevance of paradigm cases in such discussions, or levels of explanation. So for the moment, please just let the example pass; but keep in mind that these problems lurk in the shadows.

[12] Concocted cultural examples from van Fraassen (1980, 132–134) notwithstanding, but those are likely not *scientific* explanations anyway.

As a response to this criticism, among others, authors such as Wesley Salmon and James Woodward proposed causal models of explanation, which fare better in asymmetry cases. Surely we are happy to accept that the flagpole causes its shadow, but not the other way around. Therefore, causal accounts of explanation were seen as more successful in tackling this kind of case. But causation, of course, brings along with it a host of Humean problems; one is apparently cornered into realist commitments to counterfactuals, thereby dropping the essential starting point of (logical) empiricism, which is that only the actual is real.

The third problem with D-N explanations is nestled in its very stipulations, specifically the stipulation that an explanation must contain a general law. What is a general law? It must be more than simply a laundry list of specific instances, otherwise we would never be able to use it to subsume new cases. As Hempel recognized, a law "refers to a potentially infinite set of particular cases and therefore cannot be paraphrased by a finite conjunction of statements describing individual instances" (1966, 56).

But this cannot be sufficient, as Nelson Goodman showed in *Fact, Fiction and Forecast* (1954). For example, the statement "All coins in my pocket are silver." is not a law-like generalization[13] because putting a penny into my pocket would not make it silver. Even if all the coins that ever were or will be in my pocket are silver, that is to say, even if the generalization were true that all coins in my pocket are silver, it remains an accidental generalization because if another coin *were* put into my pocket, it *need not* be silver! That is to say, because there *could* be a non-silver coin in my pocket, the generalization is accidental rather than law-like. What we're talking about here is modality: law-like generalizations are able to support counterfactual conditionals, whereas accidental generalizations are not. (At least, this is the conclusion that Goodman himself drew from this case.)

According to the D-N model, the statements of the *explanans* must contain a general law, and the statements of the *explanans* must be true. Because general laws imply counterfactuals, if the laws are true, then the counterfactuals must be true. So if there are any scientific explanations, then at least some counterfactuals must be true. But this seems to overstep the crucial boundaries of (logical) empiricism, to already push us in the direction of some sort of realism.

I don't want to claim here that discussions on the topic of scientific explanation caused the pendulum to swing away from empiricism towards realist alternatives. Rather, I want to claim that there was a resurgence of metaphysical programs during this time, in the epistemology of science. Whether the problems with explanation fuelled that resurgence, or are simply an example of it, is beyond my concern here. However, it is suggestive that Bas van Fraassen, in the very same work (1980) in which he introduces constructive

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[13] One would hardly want to speak of false laws of nature, so we introduce the locution "law-like generalization" to divide the truth of a law from its law-likeness. Analogously, we can divide explanatory power from truth, allowing us to talk about potential explanations and not just real explanations.

empiricism, the most important descendant of empiricism at that time, also presents his own account of scientific explanation. In good empiricist fashion, van Fraassen points out the context-dependence, and therefore the non-objectivity, of counterfactuals (1980, 115–6). Accordingly, any nomological or causal explanation that implies the truth of counterfactuals will not be picking out the features of an objective, mind-independent world, which is (ostensibly) what science strives to do.

Rather than abandoning the issue of scientific explanation entirely, van Fraassen embraces it but with the caveat that explanation is a pragmatic issue pertaining to the interests and theories of inquirers. The explanatory relation is a relation between a particular fact and a particular theory, "which is independent of the question whether the real world, as a whole, fits that theory" (van Fraassen 1980, 98).

Van Fraassen's own, pragmatic theory articulates requests for explanation (Q) as a three-term relation between the fact to be explained (P_k), the contrast class (X), and the relevance relation (R). So his model for a why-question requesting explanation is:

$$Q = \langle P_k, X, R \rangle.$$

What we're looking to have explained is always presented (at least implicitly) as one among a number of possibilities. And what an explanation is supposed to do is to show why that event actually occurred[14] as opposed to the rest of the contrast class. What we actually offer as an explanation (perhaps, say, a further fact) van Fraassen terms "A". So A explains why P_k is the case (as opposed to the rest of X) if the relevance relation R holds between A and $\langle P_k, X \rangle$ (van Fraassen 1980, ch. 5 §4.3).

Sadly, van Fraassen says nothing about the nature of the relevance relation. He thereby imposes no restrictions upon the relevance relation R, leaving his theory unsatisfyingly underdeveloped. But that's perhaps not quite fair. Wesley Salmon claims that any explication of scientific explanation needs to "identify the kinds of objective relevance relations that make an explanation *scientifically correct*" (1989, 185; emphasis in original). What Salmon is asking for is a restriction on the relevance relation that allows us to *explain* why some story is scientifically acceptable, and van Fraassen offers no such thing. But van Fraassen is an empiricist, and according to the empiricist program, some demands for explanation are inappropriate and need not be answered. What Salmon is hoping for is a metaphysical answer to his question about relevance. Van Fraassen doesn't answer the question, leading to the realist dissatisfaction; but empiricists such as van Fraassen need not feel any such dissatisfaction as they deny the need to ask Salmon's question in the first place; again, recall that van Fraassen claims that explanation is supposed to fit facts into theories rather than demonstrate the relation between a theory and the world. We will return to that point at the end of the chapter.

However, the considerations that van Fraassen addresses in outlining his pragmatic theory are hugely helpful in advancing the discourse surrounding scientific explanation. Salmon makes the very helpful suggestion that we can actually use a pragmatic account like van Fraassen's in tandem with a causal or deductivist account, where we use

[14] Or why that particular law is the case, etc.

causation or nomological deduction to fill in the content of the relevance relation (Salmon 1989, 185). This is the realist's continuation, picking up where van Fraassen's empiricist account of explanation left off, in order to resolve a realist's *malaise*.

§1.3 Constructive empiricism

It is to van Fraassen's constructive empiricism[15] that I now turn. He nicely sums up empiricism with regard to science as follows:

> [E]mpiricism requires theories only to give a true account *of what is observable*, counting further postulated structure as a means to that end. In addition empiricists have always eschewed the reification of possibility (or its dual, necessity). Possibility and necessity they relegate to relations among ideas, or among words, as devices to facilitate the description of what is actual. So from an empiricist point of view, to serve the aims of science, the postulates need not be true, except in what they say about what is actual and empirically testable. (van Fraassen 1980, 3)

There are three salient points here that I wish to extract. First, empiricists are committed to the reality of that which is both actual and observable. Second, and this should help to clarify what is intended in the first point, empiricists are agnostic about the reality of everything that has a modality richer than actuality (e.g.: necessity, possibility) and/or that is not observable. Third, though the unobservable and the modally enriched are artifacts of our ideas rather than in the world, they may fulfill important functions in theorization. However, despite fulfilling these important functions, we should not on that basis conclude that they are real.

While the logical empiricists embraced these tenets of empiricism, they attempted to get off the boat with the modal and the unobservable through an attempt to divide language into its actual and observable components on the one hand, and the modal and unobservable components on the other. All that would then be needed is a set of translation rules to show how the latter map onto the former, and then we can retain our scientific language on a philosophically sound and metaphysically untainted footing. However, this attempt to reduce ontological and epistemological issues to linguistic ones failed: the division of language and the translation rules could never be successfully presented (van Fraassen 1980, 3–4): "we cannot interpret science, and isolate its empirical content, by saying that our language is divided into two parts" (ibid. 56).

Van Fraassen's own tactic is to separate the wheat from the chaff at a different juncture. Rather than making this division an issue of language, van Fraassen makes it an issue of epistemological commitment. In order to do so, he distinguishes empirical adequacy from truth. Empirical adequacy means that the theory "saves the phenomena," that it's able to conserve and organize observations. Truth, on the other hand, implies not only correctness about the observable parts of a theory, but also about its unobservable (and/or the modally enriched) parts. With this distinction in hand, van Fraassen is able to

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[15] I am here presenting van Fraassen's constructive empiricism circa 1980. There have been further developments since then, notably in articulating empiricism as a stance, an important idea to which we will return.

distinguish two epistemic attitudes one might take towards a theory: assertion of truth, and acceptance as empirically adequate. The former commits us to the full import of the theory, whereas the latter is a more restrained commitment, a commitment only to the observable parts of the theory being correct.

"In either case we stick our necks out: empirical adequacy goes far beyond what we can know at any given time. … Nevertheless there is a difference: the assertion of empirical adequacy is a great deal weaker than the assertion of truth, and the restraint to acceptance delivers us from metaphysics" (van Fraassen 1980, 69). What van Fraassen is getting at here is that the assertion of empirical adequacy commits us to more than just the observations that actually have been made: asserting empirical adequacy commits us to the belief that the empirical predictions and retrodictions of the theory are true, even those that we have not actually observed. However, it does not commit us to the objective truth of any of the unobservable and modal consequences of the theory, and van Fraassen takes this feature to "deliver [him] from metaphysics."

What is the practical difference here between logical empiricism and the constructive empiricism that van Fraassen put forward in 1980? Both types of empiricism are faced with the challenge of harmonizing the language of science, which is chockfull of language that seems *prima facie* to be about unobservable stuff and rich modalities, with their refusal to endorse any such spooky metaphysical stuff. There are two moving parts here: language, and belief.[16] The logical empiricists attempted to break down scientific language into observable and unobservable components, and offer translation rules to bridge the latter onto the former. This route is one of abandoning the literality of language: our language is not meant literally, but the payoff is that once we understand how the language is to be interpreted, our epistemological commitments can be read off of our language in a straightforward fashion. For example, once we recognize that talk of electrons is actually shorthand code for talk about streaks in cloud chambers (among other, observable things), then we recognize easily that in using such language the logical empiricist is not committing herself to the reality of anything more than those streaks.

For the constructive empiricist, the roles are reversed. Rather than adopting a straightforward epistemological commitment at the price of linguistic gymnastics, the constructive empiricist keeps the language simple at the price of epistemological contortion. Though the constructive empiricist uses the satanic verse of unobservables and modality in its straightforward and literal fashion, she does not actually endorse such things. Instead, she only commits herself to the fact that the theories employing such ghoulish features are empirically adequate, but not true in a more full-blooded sense.[17] This dichotomy seems unappealing: either we must admit that we cannot say what we

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[16] For a clear visualization of this taxonomy, see the table in (Chakravartty 2007, 10).
[17] Such a lack of commitment to one's words can't help but remind me of *Beyond the Fringe*. Specifically, Peter Cook's portrayal of a journalist in "The Sadder and Wiser Beaver," who says: "Just because my name's at the top of the column, you mustn't think that I'm in some way *connected* with it. It just means that I wrote it and they published it."

mean, or we must accept that we do not truly believe what we say. Is there no hope for a philosophy of science to offer us something more? We'll come back to that in a moment when we explore realism and see whether it fares any better. First, let's examine one further aspect of these two brands of empiricism.

The main problem for the logical empiricists was that they committed themselves to the idea that language about the actual and observable could be stringently demarcated from language about the modal and the unobservable. But language itself simply resisted any such division, dooming their program. However, the issue of division is still a live one for constructive empiricism, as van Fraassen is aware (1980, 54). If we couldn't divide observable from unobservable in language, is there a way for us to divide them so that we can commit epistemically to only one but not the other? It's one thing to state that one only endorses the observable content of one's theories, but quite another to actually isolate those observable elements for endorsement.

Van Fraassen's most helpful comment on this front is that "any unobservable entity will differ from the observable ones in the way it systematically lacks observable characteristics" (ibid.). He goes on to say that "If there are limits to observation, these are a subject for empirical science, and not for philosophical analysis. … I regard what is observable as a theory-independent question. It is a function of facts about us *qua* organisms in the world, … but there is not the sort of theory-dependence or relativity that could cause a logical catastrophe here" (ibid., 57–58). What van Fraassen is getting at here is that what is observable is defined by our biological hardware, and is not dependent on changes in our theoretical pictures of the world. What is observable is something that we might discover through biological science, but that biological science itself does nothing to construct observability itself.[18] So the observable are divided from the unobservable by appealing to how their properties relate to our sensory apparatus: only the observable can be detected by that apparatus directly.

One concern here is that observability might undermine the constructive empiricist project in general. Specifically, because on the one hand constructive empiricism denies the objective reality of modal facts, and on the other hand "observability" seems to implicate modal facts (namely, what we *would* observe *were* the actual conditions to be appropriate), it seems that constructive empiricism would be internally inconsistent if it required one to maintain that observability is an objective matter, studied by science.[19]

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[18] In this respect, van Fraassen seems to disregard psychological, philosophical and phenomenological evidence, according to which our sensory apparatus is not a set of isolated systems brought together by a rational and isolated mind. His picture of cognition seems much closer to that of Descartes than to that of Merleau-Ponty, for instance, and we might question whether in fact observation can be defined strictly through our sensory apparatus without integrating our theoretical picture of the world. Van Fraasen talks about "what the unaided eye discerns" (1980, 59), but the idea that the eye discerns anything unaided is taken for granted, without demonstration.

[19] This objection is found in (Ladyman 2000).

§1.4 And now for something completely different: The Stance

Van Fraassen responds to this concern, claiming that even if there is such an internal tension, which he is very cagey about admitting, then one is free to retain commitment to constructive empiricism while ceasing to be an empiricist (from whence the rejection of objective modal facts arises). So far as van Fraassen is concerned, constructive empiricism still makes the best sense of scientific practice, though its possible implication of modal realism would in fact be in tension with the core commitments of empiricism in general. But one simply need not be an empiricist to be a constructive empiricist (Monton and van Fraassen 2003, 419–421). Up to now, I have been presenting constructive empiricism and logical empiricism as *forms* of empiricism, and if we continue in that fashion, it becomes very problematic to say that one can be a constructive empiricist without being an empiricist.

However, van Fraassen himself undoes this apparent tension by distinguishing between doctrines and stances. Specifically, a doctrine is a set of putative factual claims whereas a stance is a set of policies about how to form beliefs. What I have been discussing up to now, logical and constructive empiricisms of science, are empiricist doctrines. They are claims about what scientific investigation does, and about what is objectively real. By contrast, the empirical stance is an attitude characterized by its persistent revolution against metaphysical speculation. An example of such speculation is that we have intuitive knowledge of the world, knowledge gained by some special faculty rather than by experience. Empiricism endorses experience alone as the sole source of knowledge. Recall that these are policies for forming beliefs, not putative factual claims.

Van Fraassen points out two specific features of the empiricist revolt against metaphysics: (1) a rejection of certain demands for explanation. Metaphysicians sometimes try to explain our most basic experiential phenomena, but in order to do so they need to appeal to something "behind" or "below" experience. Empiricists would reject the need for any such explanation, knowing that the only possible answers would take us beyond the realm of experience, beyond any possibility of verification. The second feature is (2) a rejection of certain proffered responses to legitimate requests for explanation. How are these two features different? The first is a rejection for certain demands for explanation, a rejection of the idea that certain things ought to be or can be explained at all. But even among those demands for explanation that are in fact legitimate, certain forms of explanation will be rejected by empiricists, namely those that appeal to anything beyond experience. That is the second feature of the empiricist revolt against metaphysics (van Fraassen 2002, 36–37).

The empirical stance is characterized by valuing experience as the sole source of knowledge, and by its deference to the methods of natural science, as the "paradigm of rational inquiry" (van Fraassen 2002, 63). In short, knowledge starts and ends with experience: it is the source of all of our knowledge, and all of our knowledge ultimately refers back only to it. And the methods of science are the archetype for the rational construction of knowledge.

It is important to distinguish empiricist doctrine from the empirical stance, because when that stance is taken to be a doctrine, it undermines itself. How so? To claim that there is nothing beyond experience is actually a metaphysical thesis, the truth of which experience itself cannot discern. In short, empiricism wishes to reject the game of metaphysical speculation; but as a doctrine rather than a stance, empiricism ends up being just another position in the metaphysical game, rather than rejecting the game outright. The policy of disregarding whatever may or may not be beyond experience, as a stance, avoids making similar metaphysical commitments, and thus does not undermine empiricism itself.

I think that we have presented enough historical material here to give a broad definition of empiricism, the main contemporary representative of antirealism, one that has a decent prospect of being general enough to address many positions, but also specific enough to engage them seriously and substantively. Please note that, moving forward, I will be primarily addressing the doctrines of empiricism and of realism. Their respective stances are also important and interesting, but I don't believe that the stances can be effectively understood without seeing how they get instantiated in their variegated doctrines. Accordingly, for the majority of this project I will focus on doctrines, where the criticisms leveled and suggestions raised by Cassirer can be most clearly expressed. However, I will return, in the fifth chapter, to his relationship to the stances underlying these doctrines. Until then, please keep in mind that I am addressing doctrine specifically, unless otherwise stated.

So, to give a summing up of the doctrines of empiricism seen thus far: Scientific empiricism is a position according to which we ought to endorse the objective reality of the observable content of our scientific theories. Scientific theories aim to inform us about a mind-independent world (van Fraassen 1980, 38), and we should accept the successful ones as empirically adequate, as saving the phenomena, but not as true of the unobservable parts of the world. Again, how one copes with the fact that scientific language refers to unobservable content will define what type of empiricist one is.

Van Fraassen notes that whether we are realists or empiricists, "in either case we stick our necks out" (1980, 69): in either case, we are extending our beliefs beyond the evidence that we have. We can believe that our theories are true of both the observable and unobservable parts of the world, or just of the observable parts. Or we can restrict our beliefs even further; we can believe only the actual observations and not extrapolate to unobserved but observable cases. That would be skepticism. Or we can believe only the *present* observations, not endorsing the reality of past observations (of which memories and other elements of present experience are our evidence). I will call this position presentism, which is a variety of skepticism, and a particularly intense variety at that. Because these positions do not seem to get serious consideration in the modern debates on this topic, I will not discuss skepticism, or its presentist variety, in any great detail. The realism–antirealism debate these days seems to be primarily between constructive empiricists and realists.

§1.5 Realism and empiricism, slings and arrows

So what is this "realism" of which I speak? Whereas I told a historical narrative to flesh out empiricism, I'll explore a set of contemporary arguments to flesh out realism. However, I'll give a first approximation at the outset. Scientific realism is the view that scientific theories, or at least the successful ones, literally describe both the observable and the unobservable parts of a mind-independent reality. There are three parameters here that I would like to flag: (1) whether or not language is construed literally, (2) how much of the world we believe is being correctly described by that language, and (3) whether that world is mind-independent.

So far, all of the positions that we have seen articulate a space for themselves by adopting different values for the first two parameters. Realism is literalist and fully committal (and I'll delve into the nooks and crannies of that commitment in a moment); logical empiricism is non-literalist, but fully committal once we get the language right; constructive empiricism is literalist, but commits only to the truth of the observable parts of the theory; skepticism is literalist, but commits only to the truth of the actual observations; and presentism is literalist, but commits only to the truth of the actual, present observations. What they all have in common is that whether we are getting things right or wrong depends on whether what we believe corresponds to or in some way matches up with (because "correspondence" is such a loaded word in philosophical contexts) a mind-independent reality.

All the action these days is in discussions between realisms of varying stripe and constructive empiricism, but I think a possibility that is being overlooked, and which has serious potential as a viable alternative, is a view according to which a mind-independent world is not the benchmark of truth. This is the kind of view that Cassirer holds, and his work has been introduced into this debate by some structural realists. But before exploring that literature, it would be helpful to explore some contemporary arguments regarding realism, as a context for structural realism and therefore a portal into Cassirer's input in this discussion.

As promised, here are some arrows that realists and constructive empiricists like to loose at one another. The first volley comes from the realists, who claim that everything other than realism leaves the success of science a miraculous coincidence.[20] And clearly miracles are not held in the highest esteem by the scientific crowd these days: we are meant to infer, then, that anything but realism would be absurd. There is some intuitive appeal to this line of reasoning; why *would* a theory that postulates electrons be so powerful if there were no such things? The real existence of electrons seems like it actually would make the success of such theories more understandable.

However, there are some difficulties with this argument, and sadly it isn't as straightforwardly acceptable as all that, despite its initial appeal. First off, we should

[20] This argument is often credited to Hilary Putnam, but Chakravartty suggests that its origins are in fact far older (2007, 4).

point out that this argument appeals to the principle of inference to the best explanation, according to which only the best explanation should be accepted as the right one. The dichotomy that the realists create with this argument is between their proffered explanation on the one hand, and the absence of explanation on the other, which is interpreted as sheer miracle. The first problem with this Miracle Argument is that it does not offer an alternative explanation against which the reality of observables is meant to compete. Van Fraassen, however, does give an alternative explanation of science, claiming that "the success of current scientific theories is no miracle. It is not even surprising to the scientific (Darwinist) mind. For any scientific theory is born into a life of fierce competition, a jungle red in tooth and claw. Only the successful theories survive—the ones which *in fact* latched on to actual regularities in nature" (1980, 40.)

Despite the beautifully poetic language about theories growing up in "a jungle red in tooth and claw," van Fraassen is not actually all that clear on how this analogy to evolution is supposed to be construed. There is a worry about circularity here, which I would like to disentangle. Circularity in this domain is tied to circularity problems in the philosophy of biology: what exactly does it mean for an individual[21] to be "fit," or "fitter" than some other individual, such that only the fittest survive? This is an important issue to resolve in biology, at least if we are to believe that Darwin was right in claiming as a central biological principle the "Extinction of less-improved forms" (Darwin 1859, 507).

If "survival" just means that an organism had more (viable) offspring, then clearly "fitness" cannot also simply be the number of (viable) offspring an individual produces. That would produce tautologous explanations: "Why did *x* survive (i.e.: have more offspring)?" "Because *x* was more fit (i.e.: had more offspring)." Not very satisfying, to be sure.[22] In the philosophy of biology literature, fitness is sometimes treated as the probability distribution of producing viable offspring, and to be more fit is to have a greater probability of leaving more offspring in the population than one's neighbour (see, e.g., Mills & Beatty 1979). This probability distribution reflects a relationship between the makeup of the organism and its surrounding environment.

So, coming back to the issue of successful theories, what does it mean for one theory to be more fit than another; and specifically, what are the two terms being related in this story about fitness? For its part, the outcome to be explained seems clear: a fitter theory will be better able to make novel predictions, account for past observations, etc. The realist, then, will say that fitness of a theory is a relation between on the one hand its postulations about unobservables, and on the other hand the unobservable furniture of the

[21] I use "individual" here advisedly, as I'm attempting to divest myself of a stake in the debate about fitness bearers. Whether fitness attaches to organisms, phenotypes or genotypes is a matter that I do not wish to discuss here, interesting as the matter is.
[22] Furthermore, defining fitness by actual reproductive outcomes alone also collapses the distinction between selection and genetic drift, where the latter is defined as a change in a species brought about specifically because of "accidental" movements in genetic makeup that we explain by the *absence* of differences in fitness. Given that drift is an important biological principle, any definition that precludes it *a priori* should be rejected.

universe. The constructive empiricist, by contrast, will say that the fitness of a theory is a relation between the postulated regularities in the observable phenomena, and those regularities themselves as they are in the world.

In this way, the realist and the constructive empiricist are addressing subtly different questions: the realist is addressing both (1) what makes theories successful in accounting for empirical evidence, and therefore acceptable for belief; and (2) what explains the observable regularities themselves that one finds in nature. The constructive empiricist only addresses the former issue, saying that a theory is successful when it picks out the regularities in nature, and leaves the issue of explaining those regularities unaddressed.

However, does the realist actually score much better on the issue of explaining natural regularities? If she postulates that the observable layer above is explained by the unobservable layer below,[23] then how does she explain the unobservable layer below? In short, we end up in a situation of infinite regress, where the line of questioning about what explains the subsequent step goes on and on, whereas our lineup of answers will necessarily be finite and must thereby fall short.

Where does that leave each position in terms of making us feel warm and coddled by our epistemological picture? The constructive empiricist simply does not recognize a need to explain regularities in the observable world; the realist recognizes such a need, but will be unable to fulfill it conclusively. The constructive empiricist has not been able to fully answer the realist's challenge to explain regularities in the observable phenomena, but in responding as he does, van Fraassen has problematised the foundation of the realist's purported answer to her own question. It turns out that the inexplicable mystery that neither is able to address is not the miraculous success of science: it's the miraculous regularity of the world itself that science attempts to track.

Let's explore some further problems with arguments of the Miracle type. Inference to the best explanation relies on having a ranking, based on the probability of truth, of the hypotheses available, as well as the belief that "the truth must be among the hypotheses one is considering" (Chakravarrty 2007, 6). But given that we do not know the nature of nature in the first place, in which case this whole discussion (and science itself) would (both) be moot, what measures can we have for the likelihood of the truth of our theories? Agreeing with evidence about observable phenomena is certainly one measure to consider. The presentists might take issue here with the reliability of that evidence, but the realists and the constructive empiricists will both appeal to this evidence in favour of their respective positions: the realists will say that this agreement between theory and observable evidence warrants belief in the truth of the theories; the constructive empiricists will say that this agreement warrants only acceptance as empirically adequate.

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[23] Taking for granted, momentarily, some layered picture of reality. But the infinite regress problem actually seems to run deep enough to survive the destruction of a layered picture: even if we don't believe in a layered structure to reality, we can still go on asking what explains a given fact/phenomenon.

What we need here to settle the issue is some piece of evidence to which one party but not the other can appeal. Suggestions such as simplicity, elegance, unification, and explanatory power have been advanced. But who's to say that the universe is simple, elegant, unified? Perhaps it's a God-awful mess out there, and perhaps it's not: we just don't know, and that's exactly what scientific investigation is supposed to figure out! Our theories represent our best attempt at knowledge of fundamental nature, but we never have a direct access to nature that affords the possibility of comparison. We may have a set of our favourite values, cherished virtues that a universe would exemplify if we had the chance to build one ourselves, but these have no bearing on the real world out there to which the realists and constructive empiricists both subscribe. That universe is independent of our minds, our constructions, and our values, say they, and so there is no good reason to believe that the universe is one way or the other with respect to these virtues. And explanatory power? As discussed earlier, we can't even seem to agree on how (or even whether) anything objectively explains anything, so that doesn't seem a promising hook on which to hang our epistemological hats in this present instance.

We have no idea what the true theory of the universe looks like, leaving us unable to rank our candidates for the position, as well as unable to determine whether or not the right candidate is among the pool vying for the job. The realists seem dreadfully unable to substantiate their claim that *only* a true theory could take account of the evidence.

And matters for the realist get worse once we put these in-principle arguments aside and start looking instead at the historical record (something that for a long time philosophers of science far too seldom did, but happily that trend is changing). The opponent of realism, having pulled the teeth of the realist's Miracle Argument and removed any semblance of its bite, will go on to gum up the works significantly by appealing to examples such as Newtonian mechanics. Newtonian mechanics was wildly successful for centuries, unifying many diverse predecessor theories and making powerful novel predictions. But it also postulated absolute space, which we gave up in Einstein's relativistic revolution. So if a theory like Newton's, one that we hail as among the most powerful in history, is one that we now believe to be false, then why should we believe that only a theory's truth could explain its success? We've just given a prime example of a false but powerful theory!

Matters may get worse still for the realist camp. Not only were some past theories quite powerful, but furthermore they were all false. If all of our past theories were false, then why should we believe anything different is the case now? By induction, if all past theories were false, then the most reasonable conclusion to reach is that our present theories are false also.

Mercifully for the realist, there is some response that she may give to mitigate the apparently disastrous consequences of such an argument. First, she can criticize the terms of the dichotomy: "past theories" is meant to denote theories that we once held, but have since disproven/abandoned; "present theories" is meant to denote theories that we presently hold, and haven't (yet?) disproven. But is this a dichotomy about *when* a theory was held to be true, or a dichotomy about disproof of theories? If the former, then the

dichotomy does not hold in the way that the critics want it to. The theories that we hold to be true now are also past theories, because we've been holding them for a while. We then need to ask: why did *only some* theories from the past get discarded while others, the ones we still hold, have been conserved? The answer to this question may disclose a salient difference, on the basis of which the realist can justify belief in some theories but not others.

If the dichotomy is one about disproof, then we need to refocus the issue by making very clear exactly what our two classes are here. If our known class, on the basis of which we will perform this induction, is the disproven theories, then what is our contrast class? Theories that we will disprove in future? That seems to be the constructive empiricist's implication in bringing up this Pessimistic Induction, but it's not warranted. After all, we have observed cases of theories that have not been disproven. We actually have more evidence than the class "disproved theories" can contain, so we shouldn't infer simply on the basis of that smaller evidential basis, i.e.: only theories that we've rejected. To do such a thing would be to select a biased sample. Neither the temporal nor the evidential interpretation of the Pessimistic Induction seems solid enough to vanquish realism as conclusively as its opponents would want. The opponent of the realist simply has to be far more clear in articulating the induction to be made before it warrants making pessimists of us all.

All the same, we might have concerns that even if science will one day produce a true theory, the theories we have right now aren't there yet. Few realists actually believe that present science is the true and final theory (Chakravartty 2007, 27–8), as even constructive realists recognize (van Fraassen 1980, 7). However, I think that we can put these concerns aside in this debate, not because they are not serious, but because they are serious for the constructive empiricist as well: after all, if the possibility is there that future evidence will show our present theories to be false, it is equally possible that future evidence will show our present theories be empirically inadequate. Recall that the constructive empiricist accused the realist of basing a heavier metaphysical commitment on the same evidence as the constructive empiricist's own, more restrained commitments to only the observable parts of theories. In short, if realism is simply the jump from empirical adequacy to full-blown truth, then whatever concerns exist about the connection between evidence and empirical adequacy will affect realism and constructive empiricism alike.

But will those concerns affect the two groups *equally*? The constructive empiricist's commitment to the empirical adequacy of a theory is less committal than the realist's committal to the truth of a theory, and this may mean that there is more at stake for the realist than for the constructive empiricist in theory change. After all, Newton's theories of motion actually were approximately empirically adequate, whereas space actually isn't (assuming that the relativity revolution in physics was not for naught) approximately absolute. So, one might conclude, while the constructive empiricists also need to do due diligence in testing their theories for empirical adequacy, they are not as threatened by the Pessimistic Induction as the realists are.

And furthermore, say the constructive empiricists, why should we make any greater commitments than we have to? Why should we sign up for the full metaphysical baggage of our theory when we can just commit to the observable parts, especially when these two conceptions of the theory are based on the same evidence? Peter Railton addresses this issue in his 1989 chapter, "Explanation and Metaphysical Controversy." Suppose we take the Literal Formulation of a scientific theory, and translate all of its terms implicating unobservables into terms only implicating observables. We'll call this the "Only-Observables Formulation" of that theory. Because the Only-Observables Formulation makes all the same observable claims as the Literal Formulation, but the latter additionally makes claims about unobservables, the Literal Formulation is more committal than the Only-Observables Formulation. If we believe that the only evidence that the realist has for holding scientific theories to be true is that they are empirically adequate, then both the Literal Formulation and the Only-Observables Formulation rest on the same evidence. Finally we can conclude, on this basis, that the same evidence supports the Only-Observables Formulation better than it supports the more committal Literal Formulation. We therefore have better reason, *prima facie*, to accept the Only-Observables Formulation than the Literal Formulation: we have better reason to be empiricists than we do to be realists.

Notice here that this hypothetical scenario bears striking resemblance to the historical dispute between realists and logical empiricists. But recall also that the downfall of logical empiricism was caused by the impossibility of giving just such an Only-Observables Formulation of a theory. However, the issue treated here can be revivified by revising the set up slightly: rather than speaking in terms of linguistic reformulation, the problem can be pitched as one of epistemic commitment. In this case, the hypothetical scenario above is representative of the realist–constructive empiricist debate, and we need only read "Literal Formulation" as "commitment to full-fledged truth," and "Only–Observables Formulation" as "commitment to empirical adequacy." Railton's original piece acknowledges this issue and deals with it nicely. I chose to present the issue in my own fashion for the sake of simplicity.

But we haven't plumbed the full depths of this problem yet. It seems at this point like the empiricist has given a pretty good argument in favour of their position, but the realist will respond that this line of argument comes with unforeseen consequences. Suppose we take our Only-Observables Formulation, and once again perform some linguistic translation: we'll take all of our terms implicating observables, and translate them into terms about actual observations. We'll call this the "Only-Observations Formulation" of the original theory. Because belief in this new formulation commits us only to the truth of actual observations, whereas the Only-Observables Formulation also commits us to possible observations for which we have no data, then the evidence will support the Only-Observations Formulation better than the Only-Observables Formulation. We therefore have better reason to be skeptics than we do to be empiricists. Once again, we can acknowledge the lesson learned by the downfall of logical empiricism and pitch this issue as one of epistemology rather than language.

But whether portrayed as an issue of epistemic commitment or of linguistic formulation, the lesson learned is the same: the greater evidential support for their position, to which the empiricist appeals to justify the move away from realism, also justifies a move away from empiricism and into skepticism (and even from skepticism to presentism). In attempting to thus deal a deathblow to realism, the empiricist undoes herself with the very same stroke of the pen. A pyrrhic victory if ever there was one, because evidential support will always favour further epistemic austerity (and the land of old General Pyrrhus is demonstrating right now that austerity isn't always a favourable course of action!).

The situation is perhaps not so black and white as all that. The empiricist needs to give reasons why we are justified in making a leap of faith out of skepticism, and has not done so in this simplified hypothetical case, but that is not to say that such reasons cannot be given. One such reason might have to do with the success of science itself: would scientific investigation be better served by individual scientists committing to realist, empiricist or skeptical positions regarding their theories? If an empirical investigation could conclude that any of these three produced consistently better scientific results, then that might be considered a reason to hold that epistemic position. But it would be a pragmatic reason: holding a belief because it's useful rather than because it's more likely to be true than its competitors. However, it is reasons reaching above and beyond evidential support to which the empiricist must appeal to justify their position, and it is difficult to see how any such reason would not be pragmatic.

The empiricist is happy accepting pragmatic reasons; the realist generally isn't. However, recall van Fraassen's lesson about stances. The empirical stance is a set of policies, not of putative factual claims. Therefore, while the empiricist may be happy with pragmatic reasons, she cannot claim that the realist is *wrong* to seek something beyond a pragmatic justification. What the empiricist must do, if she wishes to seriously affect the realist's position, is to show that the realist's doctrines are incompatible with *the realist's own stance!* So the empiricist can be satisfied with a pragmatic resolution to the problem of which epistemic position is the best to adopt; but she also must accept that this response, at least on its own, will hold no sway with the realist. It would first have to be shown why realists *ought* to accept pragmatic values (or increase their esteem for such values).

Railton closes his chapter with a charming story (1989, § IX), which I will paraphrase here because I think that it illustrates the problem so nicely. There are two traveling partners, each of whom likes beautiful, sweeping views, and also appreciates the importance of safety. One evening, while visiting an idyllic archipelago, likely somewhere in the South Pacific, they come across a group of small islands connected by a series of bridges. The two set out across the bridges, heading towards the outermost island, intending to look back at the whole archipelago and bask in the beauty of the coastal islands in the sunset. However, halfway out, one of the two friends stops and refuses to go further. "Do you not want the most sweeping view possible?" asks the first traveler. "I certainly do," replied the timid second, "it's only that I worry about how safe it is to cross bridges." "But you crossed some bridges already, even just to arrive here: if you were concerned, why did you not stay on the main island?" "Because I wanted a

more sweeping view than that island can afford." "But why will you cross *some* bridges but not all? How do you decide where to stop, when you've gone far enough?" The story ends before the second can respond, leaving the reader to supply the answer.

I feel that we've covered much territory already, and it seems an appropriate time to assess what's been accomplished and where the discussion is headed. We set out looking for a characterisation of the realist–antirealist debate in the contemporary philosophy of science, and what we've explored so far has mostly been two forms of empiricist doctrine, logical and constructive. Constructive empiricism is the principle antirealist position in these contemporary debates, but exploring logical empiricism was a very helpful way of fleshing out by contrast exactly where the constructive empiricists stands on some key issues: (1) the literality of language; and (2) the degree of epistemic commitment. Logical empiricists deny that language is to be interpreted literally, but endorse full epistemic commitment; constructive empiricists endorse the literal understanding of scientific language, but only maintain the empirical adequacy of theories; realists endorse both literal interpretations of language, and full commitment to their content. All these positions agree on (3) the notion that a mind-independent world is the arbiter of truth amongst theories, and that it is just such a mind-independent world that science aims to study.

As promised, we can now return to the discussion of how caricatured this brief history might be. Put succinctly, Cassirer will argue against (3), the claim that a mind-independent world is the target of scientific study or that such a world arbitrates between theories. Therefore, though the characterizations of logical and constructive empiricism leave out significant details,[24] the important feature that I need to derive from this history is that empiricist and realist doctrines thus far have all agreed on the mind-independence of the world. That is the tie that binds these positions together, at the level of doctrine, and undergirds the whole debate. Without that assumption, the debate does not get off the ground, and this is the linchpin to which I will return and that I will address through Cassirer's arguments.[25]

What about at the level of stances; will Cassirer's arguments address that level as well, or can his ideas only be brought to bear against doctrines? Because stances are statements about good belief-forming practices rather than being putative factual claims, his

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[24] Some further parameters that further subdivide these groups are: how to define the observable (see, for instance, Hempel 1965b); what it means to reject modal facts, specifically whether there are no modal facts whatsoever or whether modal facts are always context-sensitive, in which case there are just no *objective* modal facts (see van Fraassen 1980, 115–6); and how exactly the mind-independent world arbitrates between theories, either by compelling the adoption of a true theory, or simply by compelling the rejection of a false theory (van Fraassen 2002, §3.5).

[25] And so, if there is a realist or empiricist position that denies outright the mind-independence of the world, it will not find itself targeted by the arguments to come. It would be interesting to explore those further positions, but I feel that the net is cast wide enough as it is, and so further exploration will have to wait for later work.

arguments will not (and could not) show the empiricist or the metaphysical stance to be false. However, I believe that his work will suggest some important revisions or qualifications to the stances of empiricism and of realism. Those revisions will be most evident once we've had a chance to discuss realist doctrines in more detail, and present Cassirer's counter-arguments from his philosophy of science and the broader philosophy of symbolic forms. Accordingly, we will return to the issue of stances only in Chapter 5.

For the time being, let us launch into discussions of contemporary realist doctrine. Realism in recent decades has been shaped more by the Pessimistic Induction than by any other argument (Chakravarrty 2007, 28), and so we will explore in the next chapter how different responses to that argument have produced the contemporary varieties of realism that stand opposed to constructive empiricism, and to one another.

CHAPTER TWO

§2.1 The Pessimistic Induction

Having explored logical and constructive empiricism, let us now explore the Pessimistic Induction, as responses to that problem have determined the shape of modern tribes in the realist nation. The canonical modern form of the Pessimistic Induction is presented in Larry Laudan's article "A Confutation of Convergent Realism" (1981). In it, Laudan challenges the notion that only theories that successfully pick out the furniture of the world can be fruitful or powerful. This notion, of course, is the key to the claim that only a realist interpretation can explain the success of our scientific theories.

Laudan's strategy is to refute that claim by counterexample, and the historical instance that he uses to do so is the case of Fresnel's theory of the optical ether. According to the theory, light actually moves through a medium that carries it, a medium known as the luminiferous ether. Fresnel's theory not only to explain some already well documented phenomena: Poisson also used it to predict that the shadow of a circular disk would have a bright spot at its centre. This novel prediction was borne out in experiments; the theory was successful. However, we have since moved past Fresnel's theory, adopting Maxwell's electrodynamic theory. Maxwell changed the notion of the ether, however; his ether was four-dimensional, whereas Fresnel's relied on absolute space. Only Maxwell's ether, then, would be able to withstand the rejection of absolute space, which is exactly what happened in the Relativity Revolution of the early 20th century. Accordingly, Maxwell's electrodynamic theory of light was conserved, and his notion of the four-dimensional ether was rather re-interpreted as a field. By contrast, Fresnel's theory relied on the false supposition of absolute space, and it was shown that his ether could not exist. And yet a theory that included such an ether was successful in making novel predictions!

Given this counter-example, it seems difficult to maintain the position that science is always cumulative, and that only successfully mapping the makeup of the world would yield fruitful science. Clearly some elements of our theories get discarded along the way, not everything is conserved. The realist should be humbled by this revelation. Even well confirmed theories sometimes undergo major revisions in the advance of science, and truth cannot be viewed as the only explanation of scientific success. In fact, it remains an open question whether truth is even the best explanation of that success, especially given that a prominent physicist such as Maxwell was so impressed by the degree of confirmation of earlier ether theories, despite knowing that they were false![1]

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[1] As many authors point out, one must be cautious in taking the views of a given scientist about the history of science, and on that basis alone reading off suggested philosophical conclusions with immediate assuredness. I think that this caution is to be taken seriously, and so the conclusion that I wish to draw here is not that the success of ether theories demonstrates that truth has no role in explaining success of scientific theories. Rather, I wish to draw the weaker conclusion that the question of explaining that success must remain open so long as we have successful but false theories.

The realist–empiricist dichotomy hinges on one's commitments to unobservable and modal content of theories, and so a straightforward realism that commits to all observable and unobservable content of scientific theories is going to be in trouble (Laudan 1981, 28). And realists don't seem to fare any better if we fudge the details of the position by committing only to "approximate truth" of theories, or trying to soften the blow by committing to only "mature" theories. As Laudan nicely puts it, specifically in the case of ether theories: "I take it that *a realist would never want to say that a theory was approximately true if its central theoretical terms failed to refer*" (1981, 33; emphasis in original text). Furthermore, talk of "mature" theories is heavily based on the benefit of retrospect to pick one's horses after the race has been run, whereas one might reasonably hope that realism could tell us what to believe about present science rather than past science only.

There seem to be some cases of retention across theory change, and Laudan lists a number of forms that that may take, a number of ways that we might interpret "retention". However, he criticizes Putnam and others, who claim that these types of retention are the model of scientific advance that scientists themselves use: not only is this claim seldom substantiated with empirical evidence of its truth, but furthermore the attitudes of scientists themselves are to be taken with a grain of salt. In short, though some equations of classical mechanics may be derivable from the limits of equations found in relative physics, "*a proof of the existence of limiting relations between selected components of two theories is a far cry from a systematic proof that one theory is a limiting case of the other*" (Laudan 1981, 41–42; emphasis in original text). And even if such a systematic proof can be offered, it is quite a jump from there to the claim that scientists generally adopt this as a strategy for scientific revolution, and another jump again to the claim that this strategy is an overall success! All of us would like realism to be true; some of us just find it impossible to accept.

But not everyone finds it impossible to accept, and those who have chosen to press on in the face of adversity have recast realism in a number of different moulds. If some successful theories have central theoretical terms that, *prima facie*, fail to refer, then either we need to show that such failure was only apparent, or that in fact those were not the central terms of the theories in question. Each of these options is presently being explored in the philosophy of science literature, and I will now canvas the proposed solutions that seem to be getting the most attention.

§2.2 Entity realism

"How best to be a realist boils down to which aspects of theories one should believe" (Chakravartty 2007, 30). How can we restrict realism in order to make its commitments more acceptable in light of the Pessimistic Induction? I will explore four attempts here: entity realism, two forms of structural realism, and semirealism. The first attempt, primarily advanced by Stathis Psillos, is to restrict our commitments to the entities

postulated by our theories. This form is known as "entity realism".[2] More specifically, this is the view that "under certain conditions, one has good reason to believe that the entities described by scientific theories exist in a mind-independent reality", but that we should be "generally skeptical about the theories in which, *inter alia*, these entities are described" (Chakravartty 2007, 30). What are the "certain conditions"? Put bluntly, causal contact: entity realism is based on the intuitively appealing idea that when we have significant causal contact with an entity, it's unlikely that such an entity will be rejected by future theories in science, though we might not be getting all the theoretical details right at present. For instance, we have had much causal contact with electrons, and we've had many different theories about them, but despite the fact that we haven't always thought quite the same things to be true of electrons, we're sure that they exist because we interact with them causally.

Though we have spoken of electrons through the course of many changes in scientific theory, what we actually believed about them has differed dramatically. One need only think of Ernest Rutherford's "plum pudding" model of the atom, in which electrons were thought to be happily bobbing around in a thick pudding of positive charge (from the atom's protons, in the nucleus), and compare it to the present discussions about whether electrons are even individual objects with well-defined positions at all times. So what is it exactly that we believe in? Perhaps we believe in the cause of negative charge, whatever that may be? What a bland form of realism that would turn out to be. Here is the problem with hitching one's wagon too whole-heartedly to entities, and to the exclusion of theories: it allows successful reference to become trivial, and undermines the attraction of the Miracle Argument. For instance, if "luminiferous ether" successfully referred to whatever it is that makes propagation of light possible, then it is true that "luminiferous ether" successfully refers. But we could have postulated any old thing that we wanted, and it too would have successfully referred so long as we're willing to countenance that referring to "the cause of light propagation" can be successful even in the absence of any knowledge of the properties of that causal agent.

So radically separating a causally involved entity from anything that we know about it, i.e.: separating entities from the theories in which they figure, will make successful reference trivial. It also means that these entities, successful reference to which is both trivial and claimed to be the explanation for the success of science, are completely unknown to us: we can point to them, but can say nothing about what we're pointing at or even how we point. How does that salvage a primary ballast of realism, namely that it

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[2] As my main objective in this chapter is to kick-start the discussion of Cassirer's work in the realist–empiricist debate, I will devote but little attention to entity realism. Cassirer's writings, it is argued, support structural realism, and so that position warrants comparatively more attention. Some of the criticisms of structural realism coming from the semirealists also seem strongly in line with Cassirer's work, so that will get sustained attention as well. In fact, only entity realism is left short-changed in this discussion, not because it is to be taken any less seriously in the contemporary debate, but only because it serves nearly no purpose in introducing Cassirer's work into the debate beyond playing the foil to the other realist positions.

makes the success of science more clearly understandable than any rival position? Following the entity realist, we might be forced to say that what explains the success of science is the continued successful reference to unobserved entities; but given that we might successfully refer to them even with dramatically false theories, how does that reference make theoretical successes any more transparent to us? Successful reference devoid of theoretical input forces us to postulate The Great Mystery of the Entity, which completely undermines the realists' sales pitch about taking care of our great problem with Great Mysteries.[3]

Entity realism needs to give us more: we need not merely an in-name-only grasp on the entities, but also some purchase on the properties of those entities. We need some way to *relate* to those entities, to connect with them causally, and this will implicate the theoretical connections in which those entities stand. Theories map these properties and dispositions to interact,[4] and so entity realism can only bolster itself by recommitting to the theoretical circumstance of entities, to the theories that they had previously rejected, rather than just to the entities themselves. And this undermines entity realism as a whole.[5]

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[3] Laudan (1981, 158–159) makes similar remarks about bare reference undermining the Miracle Argument.

[4] Or so claims Chakravartty, the main proponent of semirealism, and we'll get to more of that view soon. Note also that I'm following Chakravartty's roadmap of these positions (2007, chapters 2 and 3), where semirealism is ultimately the position that is meant to conserve the most attractive parts of each theory while sidestepping their multifarious shortcomings. Ladyman and Ross present ontic structural realism in a similar fashion, as learning the hard lessons of standard realism and constructive empiricism, but I feel that their presentation fits less comfortably with the introduction of Cassirer's ideas (which is ironic, because they are the ones who introduce his work), and so have opted to follow Chakravartty's lead instead of Ladyman and Ross's.

To briefly indicate how Ladyman and Ross see their position as an evolution from standard realism and constructive empiricism, they see standard realism as hard-pressed to give an entities-based account of quantum mechanics, which justifies ontic structural realism in relinquishing any commitment to objects. However, they also see van Fraassen hard-pressed to give an account of the observable–unobservable distinction without a reliance on modalities: what is observable is defined by what we would be able to observe with our bare senses, were we suitably spatio-temporally placed. Standard realism is a commitment to observable content of theories, in addition to their unobservable and modal content. Empiricism is a commitment to theory's observable content only. Structural realism commits only to observable and modal content, eschewing unobservables because physics itself demands it, and including modal content because observability itself demands it. For van Fraassen's own discussion of observability, see (van Fraassen 1980, 57–58; Monton and van Fraassen 2003).

[5] This may be a caricatured version of entity realism. But I worry very little about that: recall that my aim here is not to strike down these views, but rather just to canvas them as a primer on the realist–empiricist debate generally and as an entry point into Cassirer's work. Ultimately, whether this is a caricature or not is relatively unimportant, as once that

§2.3 Structural realism

Structural realism is another attempt to reconcile the Pessimistic Induction and the Miracle Argument. John Worrall gives this position its seminal articulation in his 1989 article, "Structural Realism: the best of both worlds?" Worrall follows Laudan in dismissing "maturity" of theories and the approximation of truth as viable foundations on which to seat realism (Worrall 1989, 115). Like Psillos, he believes that we need to restrict realist commitments in a more principled way, rather than simply making fuzzy the details of which theories we will endorse and how. What we need is a principled distinction of which *part* of theories to endorse, and Worrall proposes that the part we should endorse is not the entities postulated by the theory: "Newton's theory does assert that space and time are absolute, that there are action-at-a-distance forces of gravity, and that inertial mass is constant; all this was entirely wrong and yet the theory based on these assumptions was highly empirically adequate. This just has to be recorded as a fact, and if you happen to find it a rather startling fact, then that's your business" (Worall 1989, 111).

So what does survive in the course of theory change? Worrall (1989, 115–119) explores Laudan's own case of the revolution from ethereal theories of light transmission to electrodynamic theories, i.e.: from Fresnel to Maxwell, to find a solution. Fresnel's picture of light is one of disturbances in the ethereal medium of transmission, but Maxwell's theory dispenses with Fresnel's notion of the ether (specifically its dependence on absolute space, and finally any ether whatsoever when the topic is re-conceptualized as a matter of fields). To insist that Fresnel was right about there being an ether, but simply that he was grossly mistaken about its nature, is surely taking the principle of charity to unknown heights, and one may well develop a troubling case of vertigo. Hence the rejection of entity realism.

But not all was lost in the transition. Rather, Worrall claims (1989, 117), there was a "continuity or accumulation in the shift, but the continuity is one of form or structure, not one of content." While Fresnel was grossly mistaken about the *nature* of light, he surely got something right about its *structure*, and this was conserved when Maxwell overturned the ether theory of light transmission. It should come as no surprise then that Fresnel's theory was overturned: after all, his notion of the nature of light was just wrong. But the success of the theory is attributed to the real structure of light that he was getting right with his theory, and that part is conserved through theory change. In this way, Worrall sees this historical case as exemplary of the Pessimistic Induction and the Miracle Argument pushing in the same direction: entities are discarded in theory change, which explains failures of theory; and structures are retained, explaining their success.

Worrall attributes the historical genesis of structural realism to Henri Poincaré, who claimed that "there is such and such a relation between this thing and that; only the something that we call motion, we now call electric current. But these are merely names

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ladder has been climbed, I can cheerily kick it out from beneath my feet—but not before dragging my reader up its rungs with me, of course.

of the images we substituted for the real objects which Nature will hide forever from our eyes" (Poincaré 1905; quoted in Worrall 1989, 118). At the level of mathematical equations relating the amplitudes of reflected and refracted light, there is continuity between Fresnel and Maxwell:[6] these equations map the real structural relations in the world. It is not typically the case that equations are conserved wholesale from one theory to another; rather, according to Niels Bohr's "correspondence principle", equations of our old theories usually re-emerge as limit cases of the equations of new theories (Worrall 1989, 120). One such case, probably the most famous, is the emergence of classical laws for the addition of velocities from relativity theory as velocity approaches zero or as the speed of light approaches infinity.[7] "On the structural realist view what Newton really discovered are the relationships between phenomena expressed in the mathematical equations of his theory" (Worrall 1989, 122).

In the realm of quantum mechanics, structural realism might fare particularly well. Whereas entity realists will need to tangle with interpreting quantum states in entity terms, structural realists need not actually worry about the nature of quantum states: their interest lies solely in the structural relations between them, and these are represented by the mathematical equations of quantum theory, not by an interpretation of the quantum states themselves. "It is a mistake to think that we need to understand the nature of quantum states at all [as opposed to their structure]; and *a fortiori* a mistake to think that we need to understand it in classical terms" as entity realism would have us do (Worrall 1989, 123).

§2.4 Epistemic structural realism

But here we have a tension. Worrall used Poincaré's writings to explicate what structural realism was all about, and the latter talked about "the objects which Nature will hide forever from our eyes", whereas in the QM case we may be dispensing with objects altogether. So which is it? Are the unknown objects out there, underlying structures that we can know? Or are there only structures and no real objects? This is the ambiguity that James Ladyman picks up and unpacks in his 1998 article, "What is Structural Realism?" In doing so, he distinguishes between two positions: epistemic structural realism, and ontic structural realism. Let us begin by exploring the former.

Here is a rough picture of how epistemic structural realists see the world. There are objects in the mind-independent world, the world in itself (yes, Kant's noumenal realm: *that* world in itself), and they stand in particular relations to one another. Those objects are represented in the phenomenal realm of experience, and those representations stand in relations that mirror the relations of the world in itself. In virtue of this mirroring, we can learn about the world's real relations by studying the relations that we find in the phenomenal realm. This mirroring comes under the heading of the Helmholtz–Weyl principle, according to which the same stimulus will always yield the same resultant phenomenon. While we can't be assured that the objects themselves at all resemble the

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[6] The doctoral thesis of Lorentz demonstrated the formal equivalence of these equations in Fresnel's and Maxwell's theories. For further details, see (Saatsi 2005, §3.1).
[7] For more details, see Ladyman and Ross 2007, 94–95.

representations we find in the phenomenal world, the mirroring of real relations by phenomenal ones assures us that we can have structural knowledge of the real world, where structural relations are just "modal relations among phenomena in the world" (Ladyman 1998, 417).

Stathis Psillos (2001, S14–S16) criticizes this conception, specifically the idea that the Helmholtz–Weyl principle undergirds the mirroring principle. In short, if the same stimulus produces the same phenomenal perception, this alone is not sufficient to guarantee that the same phenomenal perception must be caused by the same stimulus. The Helmholtz–Weyl principle is a conditional, not a biconditional, so while knowing that the stimulus is the same warrants drawing the conclusion that the perception will be the same, the inverse is not also true. The problem here can be explicated in a number of ways: if we know that a given cause always has the same effect, then we cannot necessarily reason from the effect backwards to the cause, because multiple causes might be possible avenues to that effect. Similarly, let us cast the Helmholtz–Weyl principle as a formal conditional statement: "If stimulus A, then percept B." From this conditional, and the claim that "percept B" obtains, to conclude that "stimulus A" must have occurred would be to affirm the consequent, a logical fallacy. On the basis of these considerations, Psillos rightfully concludes that the mirroring principle, on which epistemic structural realism is based, requires additional motivation, as the Helmholtz–Weyl principle will not be sufficient to do the work that needs doing.

An objection that has gotten significantly more attention in the literature on structural realism is the Newman objection, originally raised against Bertrand Russell by M. H. A. Newman in 1928, but resurrected in the contemporary context by Demopoulos and Friedman in 1985. Newman's criticism of Russell is that his structuralism makes the truth of physics trivially satisfied. How is that? The epistemic structural realist posits a domain of real objects and a set of real structures, and a mirroring domain of perceptual objects and set of perceptual structures. But, "with a minimal amount of set theory or second-order logic" (Demopoulos and Friedman 1985, 628), we can show that the structures of any two domains can be read as trivially isomorphic, so long as those two domains are of the same cardinality. As Psillos summarizes it:

> when the domain of a structure of the stimuli is fixed, a relational structure on this domain can *always be defined* (cardinality permitting) in such a way as to guarantee isomorphism between the structure of the percepts and the structure of the stimuli. Hence, the only information encoded in the claim of structural isomorphism is that the domain of the stimuli has a certain cardinality. (2001, S17)

The kernel of the objection is that any structure in the phenomena can be isomorphic to the structure in the stimuli, so long as the two domains have the same cardinality. So scientific theories, which attempt to map the structures of the real world, will be trivial: all we can conclude from mapping the structure of the world in our scientific theories is that we're getting the cardinality of the world's objects right.[8]

[8] Note that Grover Maxwell attempted to revise Russell's theory to overcome this difficulty, specifically by replacing all sentences in theories with Ramsey sentences, in

§2.5 Ontic structural realism

There are two problems with epistemic structural realism that motivate James Ladyman to develop and espouse its ontic cousin: problems of triviality; and problems in quantum mechanics, specifically trying to interpret quantum states as entities (even unknowable ones) when such interpretations are sometimes difficult to harmonize with quantum theory itself. I will treat the triviality problem only briefly, as a pivot point on which to turn towards ontic structural realism, and then more or less leave that pivot point behind. How does the ontic form overcome the triviality objections that plague espistemic structural realism? By dispensing with entities entirely. Whereas epistemic structural realism posits a set of entities and structures in the real world, with a set of representing objects and mirroring structures in the phenomenal realm, ontic structural realism commits only to structures existing in the real, mind-independent world. Those structures are mirrored in the perceptual world, but perceptual objects are merely heuristics, shorthand, useful "bookkeeping" devices for cognizing agents such as ourselves (Ladyman and Ross 2007, 5).

How does this overcome Newman's triviality objection? Let us explore the objection more concretely. It is actually a conditional statement: "If two domains of objects have the same cardinality, then their structures will be trivially isomorphic." Therefore, all that the isomorphism of our theories to the world's structure can tell us is the cardinality of the world's objects. However, ontic structural realism does away with objects in the real world, and therefore the antecedent of the conditional can never be satisfied. Instead of a focus on objects, ontic structural realism focuses on the structures themselves, which is evident in their preference for the model-theoretic view of theories as opposed to the old-fashioned syntactic view. According to the model-theoretic view, theories are sets of models; models map modal relations, which are the structure of the world. Once we start focusing on the world's structure as opposed to its objects, then isomorphism of a model with the world's structure actually tells us quite a bit: it tells us about the modal relations, i.e.: the structure, of the world![9] Thereby, the triviality problem is undercut.

What of the claim that isomorphism might be trivial? Ontic structural realists will be happy with any theory that maps the modal relations of the world, and that's what the isomorphism in question is about. It couldn't possibly be trivial! A multiplicity of

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which all mention of entities is replaced by existential quantifiers. In short, entities are not picked out by an unknown essence, but rather by their relational, structural properties; and on the nature of their nature, we remain silent. It is generally accepted that this revision is insufficient to overcome the Newman objection (see Psillos 1999; 2001; Ladyman 2009, §3.2). Furthermore, Ramseyfication is accused of reducing theories to their observable results, and this undermines realism as a whole, encroaching dangerously into empiricist territory: all observationally equivalent Ramsey sentences are equivalent. Rejigging objects in terms of observable consequences also does not fare so well in solving the problem of continuity of reference across theory change (French and Ladyman 2003, 33).

[9] For more details see (McArthur 2006, 217).

theories whose models map the world's structure won't concern the ontic structural realist. Does this sound somewhat like empiricism, that we have no way of arbitrating between empirically equivalent but incompatible theories? In fact, it should sound just like that, except that what the ontic structural realist is interested in is modal relations in the world. It is a more committal position than empiricism because it does not eschew modal relations. (In fact, it raises them to the holiest place.)[10]

But what about multiple theories that have the same modal content, but are expressed in ways that are incompatible with one another, or postulate incompatible pictures of the world's objects? Ontic structural realism only endorses the models of scientific theories: that these models can be expressed in different (and perhaps incompatible) linguistic formulations does not bother them in the slightest; no more are they bothered by different entities postulated in these different formulations of theories, because they categorically eschew entities anyway!

Perhaps this will be a nice and clear expression of the impetus underlying ontic structural realism. Whereas constructive empiricists are only interested in saving the *actual* phenomena, ontic structural realists are interested in saving the *actual and possible* phenomena (that is to say, saving the world's modal relations). Constructive empiricists maintain that scientific theories aim to capture what actually happens, whereas ontic structural realists maintain that science also aims to capture what would happen under other circumstances. They are realists about a theory's modal implications, whereas constructive empiricists deny the objective truth of modal claims. This is how ontic structural realism articulates a space between on the one hand empiricism and on the other hand traditional realism, which commits to theories' modal implications and unobservable entities. For "an explanation of what's observed [i.e.: to do justice to the Miracle Argument]… we need not go so far as belief in objects, observable or not. The positing of stable modal relations among the phenomena will do just as well" (Ladyman and Ross 2007, 106). How could isomorphism between theories ever be trivial if that very isomorphism is itself the mapping of the modal relations we're after?!

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[10] French and Ladyman (2003, 78) express the worry that without objects, they might be hard-pressed to give a notion of objectivity that does right by the realist intuitions. But the commitment to the reality of modal, structural relations seems to fulfill that need strongly enough, even without a commitment to unobservable entities. For instance, "If science tells us about objective modal relations among phenomena (both possible and actual), then occasional novel predictive success is not miraculous but to be expected. Furthermore, the fact that scientific theories support counterfactual conditionals is also explained. What differentiates the resulting form of structural realism from standard scientific realism is that the latter regards mind-independent modal relations between phenomena as supervenient on the properties of unobservable objects and the external relations between them, rather than this structure being ontologically basic. ... The structure described by theories is the modal structure of phenomena" (Ladyman 2001, 73).

Notice what's been done here: in shifting our attention from objects to modal relations, we've undercut the triviality objection of Newman. But is this really a motivation for ontic as opposed to epistemic structural realism? Is this same response not open to their epistemic cousins as well? Let us again look closely at the Newman objection, structured as a conditional statement: "If two domains of objects have the same cardinality, then their structures will be trivially isomorphic." Does the epistemic structural realist not maintain that we know nothing of the world's objects? If that's so, then how do we ever establish that the domain of real objects has the same cardinality as the domain of perceptual objects? Taking the epistemic structural realist at her word, and accepting that we know nothing about the world's objects, even their cardinality, then we can never assert that the antecedent of that conditional is fulfilled. In that case, we cannot say that structures are trivially isomorphic, as Newman's objection maintains. In fact, the epistemic structural realist can follow their ontic cousins one step further: if we focus on the structure of the world, in terms of its modal relations, then no isomorphism could be trivial. And knowledge of structural relations is explicitly the interest of epistemic structural realists, so following the ontic crowd in that direction would not undermine their position.

Looking deeper, it seems that the Newman objection might also be guilty of a formal, logical fallacy. "If two domains of objects have the same cardinality, then their structures will be trivially isomorphic." This conditional is not a biconditional, meaning that isomorphism of theories does not license us to conclude that the domains of their objects are of the same cardinality. And that was supposed to be one of the main problems that Newman raised: from the isomorphism of our models with the world's structure, all we can conclude is that their domains are of the same cardinality. That conclusion is not warranted logically. And furthermore, even if the conclusion were warranted, it would reveal that isomorphism tells us very little *about the world's objects* (namely, just their cardinality). But the epistemic structural realist isn't saying that the benefit of science is that it teaches us about the world's objects; they actually maintain that such a thing is exactly what science *does not* do.

Newman's objection therefore seems a much less powerful criticism than it may have initially appeared. First, if the epistemic structural realist maintains that we cannot know the cardinality of the world's objects, then isomorphism of scientific models with real modal structures is not trivial. Second, the reasoning backwards from isomorphism to the same cardinality of domains is logically unwarranted. Third, even to claim that all we learn from isomorphism is the cardinality of the world's objects is to disregard the main thrust of structural realism: objects are not the locus of our knowledge; structures are. The notion that isomorphism could be trivial misses the point of taking interest in structures rather than objects. And that we learn nothing helpful about objects from isomorphism actually supports epistemic structural realism, according to which we cannot have knowledge of those objects.

The Newman objection need not worry structural realists of either stripe. As both can overcome this apparent objection, it privileges neither. However, it has proven helpful in the present context as an opportunity to explore some of the similarities and differences

between ontic and epistemic structural realism. Let us now explore the other issue on which the ontic form is said to fare best: interpreting quantum states.

James Ladyman suggests that making structural realism a metaphysical thesis, that is, taking it up in its ontic form, fares better in interpreting quantum mechanics (1998, 411), where an interpretation using classical categories, such as objects, can sometimes feel like a stretch (ibid., 419–420). Let us figure out whether that is in fact so by examining the case study on which ontic structural realism most heavily relies: electrons, state permutations, and quantum statistics.[11] In classical statistical mechanics, two particles, each with a possibility of being in one of two states, produce four possible permutations. That is to say, if we have two particles, A and B, and two possible states that each can occupy, 1 and 2, then there are four possible arrangements: both particles can be in state 1; both particles can be in state 2; particle A can be in state 1, and B in state 2; or A can be in state 2, and B in state 1. Assuming that each of these permutations is equally likely, they would each have a 1/4 chance, or a probability of 0.25 (French 1989, 435).

In quantum statistics, "there is no way of distinguishing states which differ by a permutation of the particles only" (ibid., 440–441). That is to say, in quantum statistics, we only have three possible permutations: both particles can be in state 1; both particles can be in state 2; or there can be one particle in each state, *but it makes no difference which particular particle is in which particular state*, A in 1 and B in 2 or vice versa. Given only three possible permutations, and again assuming that each is equally likely, each permutation now has a 1/3 chance, or a 0.33333… probability. "It is then argued that the particles should be considered, not as individuals in the classical manner, but as non-individuals in some sense" (ibid., 441), which get their identity from the states they occupy, and states are relational/structural properties. So far so good for ontic structural realism: if the identity of electrons is determined through their structural properties, then we have a pretty strong argument in favour of the ontological priority of structure over the entities found therein.

But not so fast, argues French: an entirely different interpretation of these statistics is also possible. According to this alternate conception, the indistinguishability postulate imposes "a restriction on the possible states of the assembly such that certain of them are rendered inaccessible to the particles... This leads to a view in which quantal particles can be regarded as classical individuals which are simply prevented from occupying certain states because of an extra initial condition which has been introduced into the formalism" (ibid., 443). Whereas in the classical case we had four possible permutations, in the quantum case we have three. How do we account for this difference? In one of two ways: either by interpreting the two indistinguishable states as identical, or by showing that one of the two states actually isn't *physically* accessible. In the former case, we drop the notion of individuality for electrons and define them solely by their structural properties, much to the delight of the ontic structural realists. In the latter case, "instead of the peculiar notion of non-individuality we now have the rather odd situation in which certain states exist, ontologically speaking, but they cannot be reached by the particles

[11] The full details of this case study can be found in (French 1989).

and this is due not to the laws of quantum mechanics but to some initial condition—the indistinguishability postulate" (ibid., 444). The physical theory on its own, then, underdetermines which option we should adopt, both the individuals and the non-individuals picture remain open possibilities (ibid., 445).[12]

French and Ladyman (2003, 73) argue that this underdetermination speaks in favour of ontic structural realism. One might rightfully ask (and one rightfully does, in Votsis 2004, 23) why this underdetermination could possibly speak in favour of ontic structural realism and against its epistemic cousin. If both possibilities are still equally viable, should that not lead us to believe that both ontic and epistemic pictures of structural realism are also still equally viable? This question, reasonable as it seems, misses a subtle underlying point: the epistemic structural realists must give a principled reason to compel us to take up the individuals interpretation of QM, whereas ontic structural realists don't need to give us any principled reason to come down on either side (this point is nicely made in McArthur 2006, 221–222). Ontic structural realists are only concerned with structures, not with the nature of entities that appear in those structures. Once we've got the models and equations of the theory, French and Ladyman can pat themselves on the back, call it a day, and head to the pub for a warm pint of ale. They aren't concerned with interpreting equations, because the equations already map the modal structure of the world (assuming that quantum theory is correct), and those modal relations are all they're after. So the advantage that the ontic party derives from this case is that while epistemic structural realists need to give a principled reason to adopt one of the two possible interpretations, the ontic structural realist need motivate neither. All the work has already been done so far as they're concerned, and they don't need to resolve the underdetermination one way or the other.

The Newman objection seems far less pressing against epistemic structural realism than it originally appeared, and the interpretation of quantum mechanics speaks gently in favour of ontic structural realism. But that advantage is slight, as epistemic structural realists need to give us a good reason to take up the individuals interpretation of QM, and though that reason has yet to be given, it is not inconceivable that one should surface. In its absence, though, ontic structural realism has the upper hand because it need not motivate either of those positions. The advantage is slight, but it's not nothing either.

I've used these two concerns, the Newman objection and the QM interpretation, as a pivot point to move from epistemic structural realism to the ontic variety, but I've said precious little about what the latter position actually entails. Let's explore that in more detail now. Ontic structural realism maintains that structures, modal relations in the world, are ontologically subsistent. Whereas old-fashioned metaphysicians often maintained that structures supervene on the objects in those structures (or perhaps supervene on the properties of those objects), the ontic structural realist rejects that picture. In fact, they turn it on its head, insisting that objects are dependent on the structures in which they figure. In discussing electrons, French and Ladyman "reject the

[12] For more details on this case, see French 1998; Ladyman 2001; and French and Ladyman 2003.

assumption that … the structures in general must be ontologically supported by underlying relata… There is only charge, as part of the structure" (2003, 77). Charge isn't something used to detect an entity underlying and supporting the field: the field is primary and it is in the field that charge can appear. And the ontic structural realist crowd sees fields as "nothing but structure," a "system of effects" (Ladyman and Ross 2007, 140; the latter quoted from Cassirer's *Determinism and Indeterminism in Modern Physics*).

The ontological nature of charge is defined through the modal, relational properties of fields. The "field is nothing but structure. We can't describe its nature without recourse to the mathematical structure of field theory" (Ladyman and Ross 2007, 140). If we happen to use objects as a handy way of conceptualizing the world, we should not thereby believe that the world contains objects, much less that they're ontologically primary. Objects are useful heuristics, to be snapped back into line as soon as they tread beyond the range of their utility (French and Ladyman 2003, 42).

"On this view, elementary particles are just sets of quantities that are invariant under the symmetry groups of particle physics" (Ladyman 1998, 421). The symmetry groups themselves are promoted to the holiest ontological place. Symmetry groups are features of systems that remain invariant through the course of specified transformations. That is to say, they are what stay stable throughout the process of change. They are ontologically more fundamental than objects as "[o]bjects can be identified in terms of which symmetry transformations leave them unchanged or invariant" (Ladyman and Ross 2007, 145). Objects are identified through symmetry groups, rather than the other way around.

For example, the speed of light is invariant under changes of reference frame. No matter where or when you measure it, or how fast you're traveling, the speed of light remains constant. It is therefore invariant under a huge range of conditions. Because it is invariant in this way, it expresses a *modal structure* that is constant across a great number of reference frames (in fact, across all reference frames, if our present theories of light are anything to go by): anywhere and anywhen, a measurement of the speed of light would be equal to *C*. The nature of light, therefore, according to ontic structural realism, is dissolved into its modal structures (French and Ladyman 2003, 77), its invariance throughout explicitly delineated transformations of the frame of reference.[13]

There is some concern here that if the modal relations are ontologically primary, and we dispense with objects as mere heuristics, then we're left with a world consisting of relations without relata, and this stretches our notion of "relation" potentially too far to be recognizable. If we are forced to posit relata, then ontic structural realism cannot dispense with particulars as they claim. As Dan McArthur puts it, "The structural realist must believe that *something* stands in the relations it picks out" (2006, 212; emphasis added). But there are several responses to be made here. First, as Anjan Chakravartty points out (2007, 77), if ontic structural realism is suggesting a strong revision of our metaphysical picture, then to point out that they need to posit relata for these relations would be to beg

[13] For further articulation of these ideas, see (Ladyman and Ross 2007, 145–147).

the question: they are suggesting a conceptual revision, one according to which such a conceptual dependency need not hold (Chakravarrty 2003, 872)!

But what Ladyman and his cohort are suggesting is perhaps not quite so revisionary as all that, and so it will be helpful to figure out exactly what they intend. Their "eliminativism does not require that there be relations without relata, just that the relata not be individuals" (Ladyman 2009, §4). Ladyman and Ross suggest that it's "structures all the way down" (2007, 228).[14] The relata of structural relations are not objects, and they are not individuals; they are other structures.[15]

So the kernel of ontic structural realism is as follows: modal structures are ontologically primary and subsistent; objects are heuristic devices and should be jettisoned as an ontologically respectable category; the relata of structural relations are themselves further structures. Barry Gower (2000) worries that while this position may get us out of a few binds in quantum mechanics, such as the particle permutations issue discussed by French and outlined above, it fits less comfortably with the rest of science. This would be a serious obstacle for ontic structural realism, given that its main proponents espouse a broad naturalism (and even scientism, a mantle that they wear proudly). They have no qualms about espousing physics as a privileged, fundamental science (see Ladyman and Ross 2007, chapter 1), but they wouldn't want to go so far as rejecting out of hand all non-fundamental scientific theory. So how does structural realism fare in other areas of scientific inquiry, specifically with respect to their banishing of objects from the ontological party when those objects play central roles in the "special" sciences?

Ladyman and Ross are aware of this tension between the primacy of physics and their broad naturalism (2007, 191–192), and in response to this problem, develop what they call "Rainforest Realism." The idea here is to find a characterization of reality that permits both a respectability for all the sciences, and the intuition that physics ought to somehow have a privileged voice in scientific discourse, a voice that must be heeded by all others. What it is to be real, as outlined above, is to be a modal structure, a pattern in the data of the universe. To be a pattern is to compress that information into a more usable format. Rather than just having a map of the things we know to be true, we want rules that we can project into the unknown bits of the universe, and these rules are patterns. Ladyman and Ross follow Davies in claiming that "given some data set, the job

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[14] Given their distaste for reductionism, and specifically with the picture of science coming in "levels" (2007, §1.5), it probably would have been better advised for Ladyman and Ross to use the phrase "structures all the way *through*".

[15] As Ladyman is well aware (2001, 73), this threatens to collapse the structure/non-structure distinction that was the original key to structural realism. Recall that modern forms of realism are attempts to restrict realist commitments as a way of navigating the rough waters of the Pessimistic Induction. Structural realism was an attempt to separate the wheat from the chaff by drawing a line between relations and relata, and subscribing only to the former. But if the relata are themselves merely further relations, and so we ascribe to those as well, then the structural realists haven't actually given up anything, and thus open themselves back up to the full force of the Pessimistic Induction.

of the scientist is to find a suitable compression, which expresses the causal linkages involved" (Ladyman and Ross 2007, 221).[16]

So the job of scientists is to discern the real patterns in the data of the universe, i.e.: to figure out the laws of nature. The characteristic feature of fundamental physics (that is to say, what makes it "fundamental") is that a measurement taken at any spatiotemporal point in the universe is supposed to have bearing on its laws. By contrast, special sciences only consider information from a restricted zone of space-time. For instance, "only measurements taken in parts of the universe where agents compete for scarce resources are relevant to the generalizations of economics" (Ladyman and Ross 2007, 195). Furthermore, what is real is scale-relative (Ladyman and Ross 2007, 200). While for a time, it seemed like chemistry might be derivable from physics, and biology from chemistry, etc., the empirical winds are blowing in the other direction now, mostly because of concerns about multiple realisability: computing mechanisms can be made out of silicon chips or out of fleshy brains, and so what a computer is will be cashed out by its functional organization rather than derived from the material of its composition. This metaphysical picture is meant to resist both eliminativism and emergentism (Ladyman and Ross 2007, §5.4), allowing each science to be respectable, neither reduced to a more fundamental science nor springing forth spontaneously and thereby forcing us to posit nasty dualisms.

More specifically, though, does rainforest realism harmonize the primacy of physics with the legitimacy of the special sciences? Physics is primary because it has universal scope: if physics dictates that something is impossible, that must be respected by all the sciences, because their scopes will be nested within that of physics. But due to multiple realisability, what we learn in physics will not capture all the patterns that are out there to be found in the data. Additional patterns will be found by restricting our scope, and this is what the special sciences are up to. The patterns of those sciences are no less real; they're simply not applied in as wide a scope. And the patterns of the special sciences are not simply redundancies of the patterns found in physics (if the present trend of non-reduction pans out): while fundamental physics places a constraint on possible patterns in the special sciences, the patterns found in the latter are not derivable just from the data and patterns of physics. But for Ladyman and Ross, "When we go on to deny that, strictly speaking, there are 'things', we will mean to deny that in the material world as represented by currently accepted scientific structures, individual objects have any distinctive status. Some real patterns, we will argue, behave like things, traditionally conceived" (2007, 121), but we should not on this basis believe that things are ontologically primary or even all that respectable. The objects of the special sciences are merely heuristics, an easier way for cognitive agents such as ourselves to grapple with patterns, which are the substance of reality.

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[16] In Chapter 1, we discussed a similar idea found in Hempel: a law cannot be logically equivalent to the conjunction of a finite number of statements; it cannot be exhausted by the real, but must delve into the modal.

The special sciences are thereby accommodated. Their patterns are legitimated, not reduced, because "there are various possible ways in which real patterns at different scales can carry information about one another without inter-reducing" (Ladyman and Ross 2007, 237). While the objects that they postulate are not real, they are actually undergirded (when legitimate) by real patterns in the data, patterns that masquerade as objects. And though fundamental physics may postulate no patterns that rely on spatiotemporal continuity (as an important feature of objects), that does not preclude the possibility that some real patterns in the data can be discerned on that basis.

Similarly, just as fundamental physics may not adopt time-asymmetric processes, that does not preclude the possibility of finding some real patterns in the data that are asymmetric in this way, i.e.: the temporal symmetry of physics doesn't preclude real causal laws where causes necessarily precede effects. If fundamental physical laws delineate patterns according to which the past affects the future and vice versa, this does not *a fortiori* preclude the possibility of finding patterns in the data, at other granularity levels, where the affect only works in one direction. The laws are just patterns in data, and we are free to add additional constraints in analyzing the data. The only limit is that we cannot disregard the constraints of physics, or add constraints that would contradict those of fundamental physics. Special sciences are therefore subject to physics' constraints, but not reducible to them, and therefore still warrant our respect as independent fields of investigation. Physics only places limits on the special sciences by dictating features of patterns that *must not* be; it doesn't dictate features of patterns that *must* be (at other scales and scopes).

The relationship between the sciences is a dicey and important topic, so I will attempt to restate it for the sake of clarity. Physics tracks patterns in the total set of all data points; but if we restrict our scope to only a portion of those points, a subset of all data, then new patterns can emerge that don't hold universally outside of that selected subset. No patterns in that subset can contradict the patterns that hold in the total set; but those subset patterns also cannot be predicted from the total set alone. (At the very least, one would need the patterns of the total set *and* the principle that delineates the subset.) How this maps back onto inter-theoretic relations is as follows. Physics tracks the patterns in the universal set of data. Special sciences excise a particular subset of that data and look for patterns in that subset, acknowledging that they may not hold elsewhere; the laws found to hold there must respect the constraints set by fundamental physics, but additional constraints can be added in order to discover new patterns within the subset of data. The addition of constraints and the delineation of a subset of data from the universal set mean that the special sciences are restricted by the dictates of fundamental physics; but the laws of the special sciences are thereby not derivable from or reducible to fundamental physics.

But in this metaphysical picture, ontic structural realism may have undone itself: what exactly are the data points that these patterns compress? Surely a data point is an individual! We have not returned to entity realism, as these individuals are explicitly scale-relative, and therefore could not be ontologically prior to the structures in which they figure. But surely we've found that the relata of these modal relations are, contrary

to the insistence of ontic structural realists, particulars.[17] The structures and the patterns will be co-dependent, and this is much more reminiscent of semirealism than of ontic structural realism.

Let us examine two more objections to ontic structural realism: first, ontic structural realism espouses group theory, from which the notion of symmetry groups is drawn, and set theory. While each of these is independent of any *specific* domain of particulars, neither is free of the *need for a domain of particulars in general* (Psillos 2001, S22). In response, French and Ladyman (2003, 52) claim that if these tools necessitate a commitment to individuals, then they must be revised in accordance with the new metaphysical view that they advocate. But this flies smack in the face of their naturalist commitments, which ostensibly provide the overarching motivation for ontic structural realism in the first place! If set theory and group theory are being usefully and fruitfully applied by working scientists, and if philosophers are meant to pay deference to those scientists as Ladyman and Ross claim, then who are these philosophers to come in here and tell the scientists how to do their jobs?! The tools of set theory and group theory are working quite nicely for scientists these days, and they implicate domains of particulars. To recall the words of John Worrall: "This just has to be recorded as a fact, and if you happen to find it a rather startling fact, then that's your business" (1989, 111). Ontic structural realists have to sleep in the bed they've made for themselves in this case, and therefore to accept that present science actually does implicate individuals after all through their successful application of set theory and group theory.

The second objection brings us back to the Pessimistic Induction. Structural realism, of both types, claims that the appropriate restriction of our realist commitments is to structure as opposed to entities. But what guarantee do we have that structure will be conserved? And should we not be a bit wary of such a strong binary commitment, wholeheartedly committing to structure while entirely banishing entities? Real scientists don't seem to commit entirely to one set of things and reject completely the rest; they have varying degrees of commitment, and our metaphysical picture ought to make sense of that fact.

§2.6 Semirealism

Semirealism is a view that attempts to incorporate the hard lessons learned by each of the preceding realist positions. Let us explore some of those lessons now. Following his analysis of entity realism, Chakravartty notes that causal contact seems an important mooring for our scientific knowledge: the greater our causal contact with something (both in terms of diversity of modes of contact, and in terms of repetitions of confirmed contact), the more we are warranted to believe that such a thing is real. This does service to the point made a moment ago that our commitment to parts of theory comes in degrees, not in discreet categories of belief/non-belief (Chakravartty 2007, 32–33). But

[17] Chakravartty makes the same point about the non-individuals interpretation of electrons, as discussed in (French 1989): if we interpret electrons simply as excitations in a field, we have not gotten away from particulars, because excitations are events, and events are particulars (Chakravartty 2003, 874)!

the shortcoming of entity realism is that the belief in bare entities, to the exclusion of any of their relational properties, makes successful reference trivial, thus undermining the Miracle Argument. It also makes causal ascription very problematic, as causal contact is itself relational (i.e.: a causal relation between ourselves as observers and the content of our observations, whatever that may be). So what we learn from entity realism is that degrees of causal contact can support a very enticing picture of degrees of belief. Furthermore, whatever we believe in is going to require a relational component to be accessible via causal contact.

From structural realism of both sorts, Chakravartty distills the lesson that much structure (presented in the form of mathematical equations) has been retained across theory change, and so this structural focus should be incorporated into any new theory that we assemble. What epistemic structural realists failed to realize was that if we try too hard to eschew knowledge of entities (as Russell did in his focus on higher-order properties, a move that Grover Maxwell followed but that other epistemic structural realists need not), then our notion of structure becomes so empty as to undermine all the good work that it could have done (Chakravartty 2007, 59). Semirealism, then, should acknowledge and incorporate the insights gleaned from the structural realists by relying heavily on a notion of structure, but by not being overly concerned to divide structure from objects.

Semirealism suggests that, properly construed in light of the preceding concerns, entity realism and structural realism entail one another (Chakravartty 1998, 392). Entities are to be understood in structural terms, contrary to the position of entity realists, who maintain a picture of bare entities abstracted from their locations within theory. And structure is to be understood as relating the particulars that stand in those structures. The commitment to relata, particulars that stand in structural relations, distances semirealism from ontic structural realism. And the semirealist commitment to the notion that these relata are knowable serves to distance the position from epistemic structural realism as well. Given this interpretation of entities and structures, entity realism entails structural realism, and vice versa (Chakravartty 1998, 399–400). "When we look at their respective game plans, we find that entities and structures, though metaphysically separable, are for us epistemically interwoven, and always come as a package" (ibid., 407).

Chakravartty's position on structure seems clear enough: he definitely believes that structural relations are real, and that the properties they relate are also real, and knowable. "One should understand causal properties described in our best theories simply in terms of dispositions for relations… A concrete structure is a relation between causal properties—a particular kind of relation between particular kinds of properties, families of which are described, in summary form, in the equations of theories".[18] But given how

[18] The quote is drawn from (Chakravartty 2007, 62). He offers a revised account of causation, found in the fourth chapter of his *Metaphysics for Scientific Realism*. The thrust of his account is that properties are to be conceived dispositionally, and causal phenomena "are produced by the ways in which particulars with properties are disposed to act in concert with others" (2007, 108). This account is structural because he sees dispositions as modal structures, presented in summary form in the mathematical

much seems to hang on the nature of objects in the contemporary debate amongst realist camps, it is worthwhile to explore that issue further. For semirealism, objects are to be understood as agglomerations of properties. When properties regularly "cohere to form interesting units" (Chakravartty 2007, 63), those points of coherence are called "objects". And one does find such points of coherence! However, coherence at different levels of examination may differ, and objects therefore compose a heterogeneous kind. We need not be concerned, for example, if objects at the macro level all have the property of spatiotemporal continuity, but that those at the quantum level do not. It may simply be a fact that properties at the macro level cohere in that way but cohere differently at the quantum level (Chakravartty 2003, 876). Objects are not unknowable X's that underlie properties; they are the very points of coherence of those properties.[19]

But surely semirealism has gone too far! Recall that the motivation for all of these forms of realism was that the Pessimistic Induction threatened the realist stance, and called for a restriction of our realist commitments. The entity realists parted ways with theories, and the structural realists bade *adieu* to entities (either altogether, or just knowledge of them), but what have the semirealists given up for their humble Lenten fast? Are they not trying to get the best of both worlds and ending up with the benefit of neither? Happily not: "Surely we identify objects on the basis of certain properties—namely, those described by causal processes in virtue of which entities interact with our means of detection… It is not clear that properties are of the same type; distinguishing kinds of properties may in fact distinguish forms of realist commitment" (Chakravartty 1998, 394). The strategy of semirealism is to get on board for both the relations and the entities that stand in those relations; and to avoid the yawning jaws of the Pessimistic Induction, they divide detection properties from auxiliary properties, endorsing a commitment to the former only.

"Theories enumerate both detection and auxiliary properties, but only the former are tied to perceptual experience… To distinguish these properties, we must turn to the equations with which we attempt to capture phenomenal regularities, and ask: what do these

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equations of science. Therefore, when he speaks of causal structures, it is important to keep in mind that by this he means only that these structures are the modal dispositions, a.k.a. properties, of particulars.

[19] Chakravarrty, in analyzing the motivations for ontic structural realism, notes that an epistemic position will be evaluated based on, among other things, its primitives. Essentially, if a theory leaves more things unexplained (and, I suppose, if those things are more troubling in the absence of explanation), then it will not fare as well as a theory with fewer (and less troubling) primitives. Chakravartty acknowledges that he has precious little to say about the notion of "points of coherence of properties", and he leaves this as a primitive. However, he also notes that structural modal relations without relata is probably just as problematic in terms of primitives (2007, 871–875). Semirealism and ontic structural realism seem, to me at least, the main contenders for serious adoption as the modern form *de choix* of scientific realism; but let neither convince you, on the basis of primitives, that the other is guilty of some grand intellectual felony. Or at least don't be led to believe that the plaintiff is any less guilty.

mathematical relations minimally demand?" (Chakvravartty 1998, 395–396). When we postulate a theory, Chakravartty claims, only some of the properties laid out by the theory are implicated in detection, in our sensory contact with the outside world. These are required to give a minimal interpretation of our theories. Any other putative properties, i.e.: ones that do not play a significant role (or, more specifically, are not known to play a significant role) in our perception of the world are auxiliary properties. We commit ourselves to detection properties, as semirealists, and auxiliary properties are what we investigate through scientific experimentation.

The distinction is an epistemic one: the storehouse of known properties are detection properties; we postulate further properties, which are not strictly required by a minimal interpretation of our theories; scientific experimentation, which consists in exploring more diverse causal contact with the world, then seeks to establish whether the auxiliary property under examination is in fact real (and therefore becomes part of our established storehouse of detection properties, as that property is necessary to explain the observations of the successful experiment) or merely fictitious (and is therefore discarded, relegated to the pantheons of disproven scientific hypotheses).

These two categories are also not harshly discreet and distinct: at some point during the course of thorough experimentation, certain auxiliary properties might show promise, and we might be inclined to think that they're probably real detection properties, though we aren't yet quite sure. A property borne out by a variety of experimental tests, each conducted a sufficient number of times to instill confidence that we were not simply picking up an experimental error, would be classified as a detection property. But as we move from mere speculation, through the steps of developing new experimental verifications, and repeating each experiment, the property (assuming it passes these tests) gradually moves from an auxiliary property to a detection property, occupying grey area in between along the way.

This is how semirealism does justice to the intuition that our realist commitments are a matter of degree. The fuzziness of their boundaries is also less problematic in virtue of the fact that the categories are epistemological rather than metaphysical: we can be more or less sure that something exists, but something is rotten in the state of Denmark if we're sure that something more or less exists. By contrast, structural realism makes a clear-cut distinction between structure, which we are to endorse, and non-structure (entities wholesale, for the ontic form; the nature of entities, for the epistemic), which we are not to endorse. Once structure is identified and isolated, we are to fully endorse it, leaving no room for degrees. Similar concerns arise for entity realism, but not for semirealism.

Lest I lose anyone in my ramblings about semirealism, let us explore an example.[20] Fresnel's equations postulated a relationship between certain properties, e.g.: amplitudes and intensities of light, angles of propagation, etc. These properties are detection properties, and they are used to explain our (causal) perception of the phenomena that the theory was used to predict, e.g.: the bright spot at the centre of a shadow cast by a

[20] See (Chakravartty 1998, 396) for more details (on the example, not the ramblings).

circular disk. These are the detection properties of light, and they are necessary for a minimal interpretation of the equations of his theory; recall that equations formally equivalent to Fresnel's appeared in the theory of his successor, in the electrodynamic theory of Maxwell.[21] However, Fresnel also postulated that light travels through an ethereal medium. This medium is not implicated directly in the equations, and was a further supposition by Fresnel (a historically well-reasoned one). However, further experimentation, specifically the Michelson–Morley experiment, showed that this auxiliary property actually corresponded to nothing real, and was therefore not included in the class of detection properties. Sets of detection properties explain the success of science, fulfilling the Miracle Argument; sets of auxiliary properties are (often) deposed, falling victim to the heartless guillotine of scientific progress, as documented in the Pessimistic Induction.

If we're so worried about detection properties, and tracing things back to the observable, does semirealism risk falling back into the warm and waiting arms of empiricism? No. Recall that "as a constructive empiricist would use the terminology, one only observes something when the observation is *unaided*. One does not see cells through a microscope; instead one sees an image" (Monton and Mohler 2012, §1.6). For the semirealist, the evidence on which we judge whether to classify a property as auxiliary or detection will be experimental evidence, evidence embedded in a nexus of theory, which precludes the possibility of it being experienced unaided; "only [detection properties] are tied to perceptual experience" (Chakvravartty 20078, 395), but that is not to say that they are tied *directly* to perceptual experience. They are often tied to that experience by theoretical relationships and causal inferences. It is theory-laden evidence, theory-laden observations, that we use in distinguishing most detection properties from auxiliary properties. Thus, semirealism and (constructive) empiricism differ in their definitions of what constitutes observability. The semirealist's commitment to cells, for instance, will be that there truly are cells, rather than that cell theory is empirically adequate.

Chakravartty goes further here, pointing to "compelling arguments that suggest that perceptions of observable and unobservable entities rely on inferences which are fundamentally of the same type" (1998, 32, footnote 1). Certain forms of empiricism are motivated by the idea that "direct experience" can be the only arbiter of knowledge and that we should commit only to knowledge of "direct experience." If we require inferences to arbitrate between the veridical and the illusory, even in the realm of the observable, then "direct experience" as a whole might be undermined, putting the empiricists in dire straits,[22] and the distinction between "direct" access to observables and "indirect" access to unobservables is lost (Chakravartty 2007, 75).

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[21] See §2.1 and footnote 6 above, and (Saatsi 2005).

[22] If memory serves, a German philosopher of some repute in the late 18th Century may have made remarks to this effect. Note also that van Fraassen criticizes empistemic foundationalism in his (2002). We will return to the issue of the foundations of knowledge in the coming chapters.

If indeed ontic structural realism and semirealism are the most serious candidates these days in the realist camp, then how can we arbitrate between them? As Chakravartty notes, "unfortunately for [structural realism], scientists and theories generally describe many structures, but only some of these are likely to be retained. The realist needs a way to determine which there are, but she will not learn how to do so from either epistemic or ontic [structural realism]" (2007, 45). To this, Ladyman and Ross respond by claiming that "in most cases of scientific revolutions the empirical content of the old theory is recovered as a limiting case of the new theory" (2007, 157). The problem here is that both sides are making empirical claims about the history of science without providing any evidential proof to back up their claims. McArthur raises a similar concern about semirealism, warning that the detection properties of new theories had better not bump off the detection properties of their predecessors, lest semirealism get into hot water (2006, 213). These are all problems that would need to be solved by a thorough historical examination, which neither side offers.[23]

Chakravartty claims that structural realism and entity realism, properly construed, entail one another. In response, French and Ladyman identify that the linchpin to this mutual entailment is that relations must have relata, and one need not grant such an assumption (2003, 76). But while ontic structural realism has discarded a notion of objects, as we mentioned earlier, they do not discard a notion of relata altogether: as Ladyman and Ross put it, the relata are structures and it's "structures all the way down" (2007, 228). What ontic structural realism requires is not that there be relations with no relata, but that these relata not be individuals (Ladyman 2009, §4). But this speaks against the notion of patterns of information compressing data points, as Ladyman and Ross postulate for their Rainforest Realism, because data points are individuals; it also speaks against structures mapped by quantum mechanics relating excitations in a field, as French and Ladyman claim, because excitations are events, which are particulars. Thus, while the ontic structural realists rightly point out that Chakravartty's argument about the mutual entailment of structural realism and entity realism relies on the assumption that relations need relata, Ladyman and company actually grant that assumption themselves! Furthermore, they don't manage to argue convincingly that we shouldn't see those relata as individuals!

Chakravartty tries to give himself a leg up against the ontic crowd by inquiring into the motivation for their eliminativism. Specifically, why should underdetermination at the quantum level suggest to us that we ought to eliminate entities from our storehouse of realist commitments? After all, the identity of macro objects has been underdetermined for years, and that problem hasn't prompted us to give up our commitment to *them* (2007, 74)! To this criticism, Ladyman and his crew can take refuge in their unabashed

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[23] Anjan Chakravartty, at the 2013 annual conference of the Canadian Society for History and Philosophy of Science, raised some interesting problems regarding the capacity of historical examinations to settle such questions. In short, it isn't clear that these historical narratives can be generated in a position-neutral manner, undermining the possibility wholesale for an objective resolution to the question of which interpretation "best fits the history", as if "the history" were an unconstructed set of facts that one need only fit.

scientism: the underdetermination of macro objects results from the problems of the neo-scholastic metaphysician (as they derisively term the majority of metaphysics since Russell, excluding their own work of course), whereas the underdetermination we're talking about at the quantum level arises from scientific concerns, and those are the only ones that count. For instance, just because a group of philosophers worries about whether one would be the same person in the case of hypothetical body swap, or whether a ship can retain its identity while being progressively rebuilt at sea, that doesn't constitute an underdetermination worth caring about. But if something printed in a peer-reviewed science journal raised a similar red flag, well then we'd have a discussion on our hands. Hence, Chakravarrty's objection might be defused by simply rejecting the idea that macroscopic objects have underdetermined identities; the only suggestions of underdetermination come from disreputable sources.

We seem to be running short of issues on which to settle this dispute between semirealism and ontic structural realism. Chakravarrty notes, briefly, that the main difference between his position and that of Ladyman and his merry band of mischief-makers is:

> According to semirealism, the causal properties that one associates with the nature of an entity may be present in circumstances in which various structural relations – manifestations these properties confer dispositions *for* – do not obtain. No doubt *some* relation (or relations) involving a concrete entity obtains at any time during which the entity can be said to exist, but since causal properties generally confer dispositions for many different relations, they are generally present quite independent of whether any one specific disposition happens to be manifesting. (2007, 85)

In short, Chakravartty sees semirealism as permitting entities to stand in actual relations at any one time, while still having the disposition to stand in other relations *even if those aren't presently manifested*. He thus believes in a mind-independent world that includes actual structures, possible structures, and entities as points of convergence in those structures.[24]

But what do the ontic structural realists believe? Contrary to Chakravartty's characterization, ontic structural realists believe that "there are mind independent modal relations between phenomena (both possible and actual)" (French and Ladyman 2003, 46); they're on board for actual and possible structures, just like semirealism. They also believe in points of convergence in these structures. Unlike semirealism, however, they do not believe that these convergences are objects, at least not traditionally conceived. So what is their position on relata? They aren't objects. And Ladyman claims that they aren't particulars (2009, §4), but then the examples of relata that they give (e.g.: excitations in fields) actually are particulars.

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[24] Of course, Chakravartty only believes in the bits that are well confirmed by causal contact, i.e.: detection properties but not auxiliary properties, but we've already seen that the issue of whether all detection properties are retained or only some, and similarly whether all structure is retained or only some, is a sticky (questionably-)empirical matter that neither side has satisfactorily resolved, or even begun to seriously address.

So ultimately this seems to be the relationship between semirealism and ontic structural realism: they both endorse actual and possible structures (though they differ on which ones they endorse), and they both endorse points of convergence in those relations. The two major dividing points are objects and relata. Semirealism believes that objects need to be reinterpreted as points of convergence in structures, and it clearly endorses particulars as the relata of the world's structures. Ontic structural realism rejects the traditional notion of objects, but rather than offering a revised notion to retain the concept in their fundamental ontology, they simply accept that the traditional term has a merely heuristic application. As for the relata, they are not consistent in their views.

Which fares better? Given how much they have in common, neither seems likely to conclusively stand head and shoulders above its rival. The only advantage I can see is that semirealism is clear in its position on the relata, while ontic structural realism is murky and inconsistent.

§2.7 Summing it up, and moving on

The first two chapters, taken together, canvas the major players in the empiricist and realist camps nowadays. Along the way, I have tried to point out strengths and weaknesses, highlight differences and commonalities, etc. Let us recap some of the parameters in play in these discussions. The three main parameters are (1) literality of language, (2) degree of epistemic commitment, and (3) the mind-independent world as arbiter of truth and falsity. Empiricist doctrines will deny either that scientific language is to be taken literally, or that we are to whole-heartedly endorse the full-blown truth of theories. Realist doctrines will accept both a literal interpretation of theories and their full-blown truth. But as we've seen in this chapter, that requires coping with past failures and scientific revolutions, prompting the development of ways to restrict realist commitments. Proposals include the division of entities from structures, and the division between detection and auxiliary properties. All these positions, however, agree on (3), the fact that a mind-independent world arbitrates between truth and falsity. To put it plainly, the mind independence of the world is just the notion that the world will "push back," irrespective of the theories we hold about it or the questions we ask of it. There are objective facts that stand outside of any theorization, and theories are made and broken by their ability to accommodate such facts.

But the work is by no means finished: it's only just begun! The groundwork has been laid to explore a new position, one that questions the fundamental assumption implicit in all of the positions discussed thus far: the mind-independence of the world, parameter (3) above. In order to develop such a position, I will draw on the work of Ernst Cassirer. His name has already been dragged into this debate, in fact. Some structural realists have claimed that he is one of their own, and others have approvingly cited his writings, but I contend that they have grossly misread his work, and grossly underestimated the true value of his ideas in attempting to resolve the realism–empiricism dispute. I will begin the next chapter by exploring their reading of Cassirer, and then try to find out where they go wrong…

CHAPTER THREE

I will begin this chapter by presenting and analyzing some of the claims from the structural realist camp relating to Cassirer. To scholars who focus more substantially on Cassirer's work, any claims that he can be affiliated with realism (of any stripe) must seem very misguided, as there is an obvious tension between Cassirer's Neokantian project and realism of any stripe. In short, Cassirer picks up from Kant in arguing that knowledge is about an immanent world rather than a mind-independent one; the central feature of the realist–empiricist divide, as I've argued in the foregoing chapters, is that a mind-independent world arbitrates between true and false theories. Clearly, then, there is an apparent tension between Cassirer and any position on the realist–empiricist spectrum, the spectrum on which structural realism is located. Is this tension merely apparent, or is it borne out upon closer scrutiny? Up to now there have been no in-depth studies of Cassirer's arguments in the context of the realist–empiricist debate,[1] and so what I will offer here is just such an elucidation. In this chapter in particular, I will examine the structural realists' reading of Cassirer, and then show, through an exposition of Cassirer's philosophy of science, where their reading falls short. What I aim to settle is whether Cassirer can in fact be co-opted to the cause of structural realism, and more globally whether he can be said to endorse any position on the realist–empiricist spectrum in general.

§3.1 Cassirer as epistemic structural realist…?

So how exactly are the structural realists understanding his work? There are in fact two readings of Cassirer to be found in the structural realist camp. The first thesis, the stronger of the pair, is that Cassirer just is a structural realist. This reading is found in Barry Gower's "Cassirer, Schlick and 'Structural' Realism" (2000). Gower attempts to bring Cassirer's work to the service of the epistemic form of structural realism. The second reading, this time more modest, is that Cassirer himself could not have been a structural realist because of his Neokantian leanings. However, he provides a structuralist

[1] For a time, I worried that I'd been scooped: Georges Ibongu's four-chapter study, entitled *Cassirer's Structural Realism*, suggested that the present project had perhaps already been carried out. However, upon further investigation, it seems that while Ibongu's treatment of Cassirer is quite interesting, it falls short in a few respects. First, it lacks any thorough exposition of structural realism itself. Second, and because of the first, Ibongu isn't able to show exactly where Cassirer converges with and diverges from structural realism, as the latter position simply isn't described in enough detail to permit this. Third, and most importantly, Ibongu explores Cassirer's philosophy of science without situating it within the broader project of the symbolic forms, which is crucial to understanding Cassirer's thought. My work here hopefully continues what Ibongu has ably started, outlining structural realism (and situating it within the realism–empiricism debate) in Chapters 1 and 2; comparing and contrasting it to Cassirer's philosophy of science here in Chapter 3; and exploring the place of science in the philosophy of symbolic forms in Chapter 4.

conception of quantum mechanics that might be fruitful if removed from its Neokantian moorings and grounded within a realist epistemology instead. This reading is found in French and Ladyman's "Remodelling Structural Realism" (2003) and the third chapter of Ladyman and Ross's *Every Thing Must Go* (2007).

Addressing the strong thesis first, why would anyone get the idea that Cassirer is a structural realist? As Gower sees it, the central idea of structural realism "is that scientific theories do indeed provide information unavailable to us in observation and experimentation, but that information is about the form or structure, rather than the nature or content, of what is unobservable" (Gower 2000, 73). No wonder, then, that he sees shadows of just such a position when he reads passages such as the following:

> we do not know, indeed, the real absolutely in its isolated, self-existent properties, but we rather know the rules under which this real stands and in accordance with which it changes. What we discover clearly and as a fact without any hypothetical addition is the law in the phenomena. … we never know things as they are in themselves, but only in their mutual relations. (Cassirer 1910, 304; quoted in Gower 2000, 92)

Gower sees here Cassirer's rejection of atomistic knowledge of individuals and his espousal, instead, of structural knowledge about how things are inter-related, and Gower draws the connection to epistemic structural realism, according to which scientific knowledge is always *structural* but tells us nothing about the *nature* of entities, which is forever hidden from our eyes.

This knowledge of structures exceeds the observable, placing Cassirer outside the empiricist camp and among the realists, according to Gower. However, while Gower claims that Cassirer is a realist, he also remarks that "Neither [Cassirer nor Schlick, whom Gower also discusses in his article] is willing to endorse a *naïve* or *'dogmatic'* realism which claims that by exercising our cognitive powers in accordance with the scientific method, we can achieve in scientific theories knowledge of *a reality existing quite independently of those cognitive powers*" (Gower 2000, 101–2; emphasis added). But as we have been elaborating in the first two chapters of our present discussion, the mind-independence of the world is a fundamental feature of realism, and in fact of the whole realism–empiricism debate. Unfortunately, once that feature is removed, realism is mutilated beyond recognition, and Gower offers no further remarks about how we are to understand the "realism" of Cassirer (or of Schlick, for that matter). How do the positions discussed by Gower map onto structural realism, as presented in the previous chapter? It's impossible to say, as he simply doesn't offer enough detail.

Gower's interpretation of Cassirer, going by his bibliographic entries and footnotes, relies on only two works of Cassirer's: "Kant und die moderne Mathematik" (1907) and *Substance and Function* (1910). Furthermore, much of Gower's interpretation is derived from Thomas Ryckman's essay "Zuordnung in the Early Epistemologies of Cassirer and Schlick" (1991). The resulting picture that Gower offers is unfortunately superficial. And while Ryckman explicitly acknowledges that he is presenting a picture of Cassirer's earlier works, from "his pre-*Symbolic Forms* or Marburg period" (1991, 57), Gower makes no such acknowledgment.

Gower's reading of Cassirer is as a result extremely limited, and he is led to overlook obvious clues such as the following, which raise serious concerns for interpreting Cassirer as an epistemic structural realist: "All the weapons of ridicule are summoned against the assumption of an independent, separate 'something' without properties, which is assumed to be the 'bearer' of sensuous qualities" (Cassirer 1910, 330–1). Cassirer disavows any postulation of an unknown and unknowable substrate for our knowledge, and exactly this kind of substrate is characteristic of epistemic structural realism, according to which we have knowledge only of the structural relations of the world but not of its unknowable objects.

In the realm of field theories, mostly treated in *Determinism and Indeterminism in Modern Physics* (1936), which Gower does not cite at all, Cassirer argues explicitly against a substantial substrate, concluding that "the field is a complex of pure effects of, or pure relations between, 'lines of force' which are no longer necessarily tied to a material substratum but which determine physical events, as it were, by their free mutual interaction" (Cassirer 1936, 131). Here, Cassirer pulls the carpet out from underneath a substantialistic view of science, arguing not that objects are unknowable postulates lying beneath these relations, but rather that the relations themselves must be our starting point. Objects are no longer to be understood as persistent and ontologically primary:

> The concept of law is now regarded as prior to that of object, whereas it used to be subordinate to it. In the substantialistic conception there used to be a definitely determined entity, which bore certain attributes and which entered, with other entities, into definite relations expressible by the laws of nature. In the functional viewpoint, by contrast, this entity constitutes no longer the self-evident starting point but the final goal and end of the considerations: the *terminus a quo* has become a *terminus ad quem*. (Cassirer 1936, 131)

I want to say very little more about the strong thesis here, because I believe that arguing against the weaker thesis, and showing even that to be untenable, will be far more constructive both in the local debate about whether Cassirer's structuralism can be brought to the service of structural realism and in the larger and far more important dispute between realism and empiricism. I've presented only a few quick conclusions, and none of the arguments supporting them, to the effect that Cassirer does not endorse a substantialistic interpretation of modern science. He therefore cannot be allied with epistemic structural realism, which seeks to restrict our epistemic commitment to structural claims alone, but otherwise leaves untouched the metaphysical picture of subsistent entities and supervening laws.

§3.2 Cassirer as ontic structural realist…?

Given the quote above about the concept of law being prior to that of object, there may at least remain initial promise for Cassirer to be adopted as an ally to the cause of ontic structural realism. After all, it seems quite in line with the following statement of the metaphysical commitments characteristic of ontic structural realism: "there are mind independent relations between phenomena (both possible and actual), but these relations

are not supervenient on the properties of unobservable objects and the external relations between them, rather this structure is ontologically basic" (French and Ladyman 2003, 46).

Though Ladyman explicitly recognizes that Cassirer's Neokantianism is incompatible with realism in general, he asserts hopefully that "it may be worth exploring the possibility of detaching his account of objectivity from this [Neokantian] programme, particularly as [Cassirer] was so clearly aware of, and thought it important to accommodate, the implications of quantum mechanics for the metaphysics of objects" (French and Ladyman 2003, 38).

Ontic structural realists wish to retain Cassirer's conclusions about the ontological primacy of laws and the secondary nature of objects, but do not want to get embroiled in Cassirer's account of objectivity: "It is precisely at this point, where the neo-Kantian expresses the constitutive role of laws in experience, that the structural realist departs," (French and Ladyman 2003, 40). Realists will break off at this point because, for them, objectivity is grounded by a mind-independent world, not by the conditions of possibility for the experience of objects, which is the position of Kant and the Neokantians.

Is it possible to conserve Cassirer's anti-substantialism and yet retain a realist epistemology about the grounding of science? Ontic structural realists say that it "may be worth exploring" the possibility, but clearly aren't terribly concerned to carry out any such exploration, as they give no indication of how it is supposed to work. Exploring just such a possibility is the goal of this chapter, and that will require diving into the details of Cassirer's arguments in *Substance and Function*, as well as *Determinism and Indeterminism in Modern Physics*, which are his two most important and direct contributions to the philosophy of science. But before we do so, let us just explore which of Cassirer's commitments the ontic structural realists seek to endorse, and which commitments they reject.

Both the ontic structural realists and Cassirer wish to reject the traditional (caricatured) Aristotelian picture of reality, according to which substances are the bearers of properties and structures are merely supervenient on those properties, and therefore substance-dependent. Both camps also agree that it is scientific advances, namely in field theories, that prompt this revision. And this is not an exceptional circumstance: they both agree that science ought to play an ongoing role in the shaping of our fundamental ontology. The lesson that relativity theory and quantum mechanics has to teach us is that science teaches us about structures rather than objects;[2] the objects of our theories emerge from the structures, not the other way around.[3]

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[2] For more, see: (Cassirer 1936, 195; Gower 2000, 89; Ladyman and Ross 2007, 140; Ibongu 2011, 11).

[3] So when we speak of the Higgs Boson as the "God particle", as is often done in popular writings on the subject (e.g.: Dan Brown's *Angels and Demons*, which introduced a huge lay audience to the topic), it is because this particle is supposed to help us explain how mass emerges from fields, which are mass-less. The creation of mass out of non-mass is

Furthermore, both parties agree that conditions of measurement should constitute objectivity.[4] What does that mean, practically speaking? Our physical theories describe the possibilities of taking certain measurements, and when our theories tell us it would be impossible to take a measurement, we should not speculate about what value that parameter takes when we can't measure it.

The Compton effect is a perfect illustration of this problem. If we wish to determine the position or the momentum of an electron, we follow a similar procedure in either case: we fire a photon at it. If we fire a photon of very high energy, we can localize the electron's position very accurately; but when we induce this high-energy collision, we send the electron spinning off wildly, and consequently have very little information about its momentum. Conversely, we can tap it very lightly with a low-energy photon, thereby taking a reading of its momentum without sending it drastically off course, but that doesn't allow us to localize its position very accurately. Each of these tests affects the particle, so if we were to run one and then the other (i.e.: if we were to hit it with a low-energy photon and then a high-energy one, or vice versa), the outcome of the second test would be affected by the influence of conducting the first. Thus, if we wish to take a reading on the electron as it is, devoid of any experimental influence, we only get a single shot at a given electron. So we are faced with striking a balance between the accuracy of position and the accuracy of momentum. We simply cannot have accurate measures of both, in accordance with Heisenberg's uncertainty principle.[5]

According to one interpretation of this problem, some scientists have speculated that electrons must have a determinate position and momentum at all times, and that Heisenberg's uncertainty principle expresses only a limitation on the reaches of our knowledge.[6] That is to say, some physicists believe that each electron really has a fully defined position and momentum at every moment, and that quantum physics is

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compared to creation *ex nihilo*, for example by Laurence Krauss in *A Universe from Nothing*, and therefore meant to disprove divine creation, supposedly the last trump card of religion, according to Richard Dawkins. Of course, this is not creation *ex nihilo*: mass emerges from the field, not from nothing; that's the whole idea. This is an interesting point of divergence between the ontic structural realists and the kind of hyper-reductionistic, vitriolic, radically anti-anything-but-science crowd, including Krauss, Dawkins, Stephen Weinberg and Stephen Hawking. Ontic structural realists aren't saying that elements within the field emerge from nothing; they're saying that those elements arise *from the structural relations of the field*. And structural relations aren't nothing to ontic structural realists. On the contrary, they think that structure is quite something. Everything, in fact.

[4] For more, see: (Cassirer 1936, 128; French and Ladyman 2003, 39; Ibongu 2011, 24).

[5] More recently, it has been suggested that the mechanical interference of our experiment is not the culprit here, and that in fact complementarity is more fundamental than the uncertainty principle. See Appendix Ψ for more details.

[6] See, for instance, (Einstein, Podolsky and Rosen 1935). Such theories are known as "hidden variable theories."

consequently incomplete because it can only give us a partial picture of determinate reality. Ontic structural realists and Cassirer agree that we should not impose such *a priori* speculations on the objects of science: if in principle we cannot measure a property at a given time, it has no value at that time. The conditions of the possibility of measurement map the reality of the object. If we cannot measure the position or momentum of an electron at a given time, *it has no position or momentum at that time*. It is not simply that the position or momentum is there, but we can't see it; it actually isn't there to be measured. Thus, the conditions of measurement are related to objectivity itself.

One objection against ontic structural realism is that this position has trouble distinguishing mathematical from physical structure. A traditional realist could say that physics is about the world's objects, while math may not be; but that line of response is clearly not open to the ontic structural realists, who deny that the world is anything over and above structure. French and Ladyman mention (more as a note than as a response to the objection; see their 2003, 45; and Cassirer 1936, 195–6) that Cassirer's structural account of mathematics and physics also blurs the line between these two disciplines, indicating yet one more point of convergence between their position and Cassirer's.

The final alleged similarity is that Cassirer, just like ontic structural realists, claims that superseded scientific theories are retained during the course of revolutionary theory change. Recall that structural realists used this retention as an argument against the Pessimistic Induction. Cassirer, demonstrating once again his inspiring ability to draw on a rich diversity of intellectual lines, approvingly quotes Einstein, according to whom "the most beautiful fate of a physical theory is to point the way to the establishment of a more inclusive theory, in which it lives on as a limiting case" (quoted in Cassirer 1910, 378). Ontic structural realists describe this retention by limit as a partial isomorphism: any theory that gets retained as a limit case of its successor partially maps onto the true theory.

The major difference between the views is that ontic structural realism wants to reject Cassirer's account of objectivity, according to which scientific practice itself is partially constitutive of the world. Mind-independence is a central tenet of realism, and therefore not up for grabs; but Cassirer will deny it, so clearly this aspect of his theory has to go. So far as realists are concerned, our scientific theories play no actual role in shaping the real world. Rather, that world sits, stoic and obstinate, as the arbiter of our finite and limited theorizations.

§3.3 Against abstraction

The looming question here, of course, is whether one can pick and choose the conclusions one wishes to support. Do Cassirer's structuralist commitments and his Neokantian epistemology each spring from different sources, allowing one to selectively endorse some while dropping others; or do they flow from a single argument, in which case a principled reason must be given for following his argument only so far? Simply embracing the wistful hope of divisibility offers little consolation. In the present section, I will outline Cassirer's arguments against the abstraction theory of concept formation,

which forms the basis of his rejection of substantialism. This will be the first step in assessing whether ontic structural realism has the argumentative resources needed to draw the division it would need in order to endorse his structuralism without endorsing his broader epistemology.

To begin, let's give a brief description of the abstraction theory of concept formation, in order to get some feeling for the position that Cassirer's arguments will attack here.[7] According to abstraction theory, objects present themselves before us, in all their diversity and multiplicity. The mind then groups them according to similarity and abstracts away the differences. What is common to a set of similar objects, then, forms a concept. As we proceed in this way, our concepts rise to greater and greater generality, as more universal concepts include more objects. We ascend the phylogenetic tree by abstracting away more and more details, and we descend back down the tree by adding those details back in. The general concepts thereby contain the more specific concepts within them. The role of the mind in all of this is just to group objects by similarity and to form concepts that encapsulate those similarities. Concepts, then, are not foreign to reality, but are rather a selection of properties contained within given objects. This notion of concept formation dates back at least as far as Aristotle, and certainly plays a prominent role in his work.

In Cassirer's work, one finds five arguments against the abstractionist picture, and I will now explore each one in turn. Let's embark on the first argument. As a Neokantian, particularly of the Marburg school, Cassirer's interest was to do justice to the "fact of science." *Substance and Function*, in particular, assesses the prospects for Aristotelian abstractionism to determine whether such a theory can do justice to the concepts that we find in the natural sciences.[8] One of Cassirer's major concerns is that as we climb the tree of concepts, we gradually encompass a greater and greater number of particular items, but the concepts themselves have less and less meaning (Cassirer 1910, 6). As extensional content waxes, intensional content wanes, if you will. The most general possible concept includes everything by saying nothing. And therein lies the rub: concepts of this sort do not encompass more objects by actively *including* them, but by passively *not excluding* them. We arrive at an abstract rather than a concrete universality. The particularity of objects is not retained in concepts: it is tossed aside. Concepts, therefore, do not help us to approach the truth, but rather distance us from it more and more (Cassirer 1910, 18–19).

In science, the formation of concepts and laws is supposed to clarify reality to us, not make it more opaque. "The concept would lose all value if it meant merely the neglect of the particular cases from which it starts, and the annihilation of their particularity… the

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[7] Cassirer's own description of abstraction theory can be found throughout *Substance and Function*, as he unrolls his counter-arguments, but he gives an initial characterization in (1910, 4–5).

[8] For comprehensive and accessible treatments of Cassirer's historical situation, Michael Friedman and Thomas Ryckman are particularly helpful guides. See: (Friedman 2000; 2003; 2005; Ryckman 1991; 2003).

higher concept is to make the lower concept intelligible by setting forth in abstraction the *ground* of its special form. The traditional rule, however, for the formation of the generic concept contains in itself no guarantee that this end will be actually achieved" (Cassirer 1910, 6).[9] Mathematics retains its particulars by being able to deduce them; it "takes up into itself the peculiarities of all the species and develops them according to a rule" (Cassirer 1910, 20). Abstraction, by contrast, just loses particulars entirely, and therefore cannot do justice to mathematical concepts. That is Cassirer's first objection.

The second objection to abstraction theory is that it presupposes that our concepts all originate "out there" in the given-ness of the world. But science operates with concepts unlike anything we ever experience in that raw kind of way. There are no such things as frictionless planes, perfectly round or uniformly dense objects. These things simply do not exist. We therefore cannot pull them out of the real world by abstraction. Of course, we say that there are objects that *approximate* such properties, but it is only in virtue of having the ideal in mind *beforehand* that we can say a real object can approximate such an ideal as a limit case. If we did not have these ideals to work with beforehand, we could never recognize a real object as approximating the ideal. The calculations in science get their deductive certainty from dealing with these idealized cases, which the real only approximate; and that ideal cannot be derived from objects given to us fully formed in experience. This process of idealization happens as much in math as it does in geometry and physics.[10]

The third objection is related to the second: not only do we need idealized concepts beforehand in order for real objects to appear as their approximations, but we also need scientific laws in order to run real tests on these idealized objects. For example, Lobatchefsky proposed to test the curvature of space by constructing a triangle whose base would be the diameter of Earth's orbit, and whose third vertex would be . As Poincaré pointed out, any conclusions drawn from such an experiment would be problematic, as it would not be clear whether it was a problem to be solved by geometry or by physics: would the failure of the experiment indicate that light moves in straight lines through curved space, or that it moves in curved lines through straight space? No answer to this question can be gleaned from the experiment alone. Geometrical theories can never be tested on real objects without also relying on physical theories.[11] "Since the investigation of material things never touches the ideal circle or straight line, we never gain in this way a decision among different systems of geometry" (Cassirer 1910, 108). Even in the simple act of measuring the length of a rod using a ruler, one must assume that the ruler is absolutely straight; one must idealize the measuring instrument. We never

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[9] Aristotle's metaphysics provided that guarantee, so now that we're operating with a different metaphysical program, no such guarantee exists. See (Cassirer 1910, 7). For further discussion of the first objection to abstraction theory, see (Capeillères 2007, 336; Verene 2011, 6–7).

[10] For more details about the second objection, see (Cassirer 1910, 13–14; Gawronsky 1949, 217).

[11] For more details about the third objection, see (Cassirer 1910, 430–437; Heis 2010b; Heis forthcoming).

measure with a real, finite, flawed instrument, but always with its idealization (Cassirer 1910, 427).

This objection really points to a larger issue: the problematic nature of epistemic atomism. Abstraction theory presupposes that there are particular objects that ground our knowledge claims; our concepts are supposedly justified by the fact that individual objects are unproblematically given in experience and that concepts are merely selections from the properties that already belong to the given object. The first objection raised against abstractionism shows that the concepts of mathematics and science don't neglect particularity as abstraction theory requires; the second and third objections show that the practice of scientific measurement and experimentation already must presuppose a network of theoretical interconnections, one that necessarily includes idealizations and the mind.

The second and third objections, therefore, undermine the idea that there is *anything* unproblematically given that could act as a grounding post for science. We never start from raw material, but are constantly building theory from within a theory-laden world. Theory therefore cannot be tied back to or justified by raw material.[12] Even measurements, the rawest material of science, turn out to be not so raw after all. These problems undermine not only an abstraction theory of concept formation, but also the assumption of a mind-independent world: all of scientific experience indelibly includes idealized elements supplied by the mind.

The fourth objection raises concerns about grouping. Let's explore an example. There is a multitude of objects before me, of differing shapes, sizes and colours. I then group them by colour, separating out, say, all the blue objects. I then retain only that which is common to them, namely their blue-ness, and thus form my concept of "blue." But how could this be the origin of my concept? I already needed to recognize that they were blue *in order to group them according to that property!* Their similarity *just is* their partaking of a common property; it is only in virtue of sharing that property that they are similar, so it could not be their similarity that teaches me the property. Abstraction theory here actually elides right over the very thing that it's meant to explain! Concepts are used to group objects in the first place, so the grouping itself cannot be used as the origin of our concepts.

What needs explaining is how we group. "While the empiricistic doctrine [i.e.: abstractionist picture of content formation] regards the 'similarity' of certain contents of perception as a self-evident psychological fact which it applies in explaining the formulation of concepts, it is justly pointed out in opposition that the similarity of the

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[12] Furthermore, some experiences are admittedly hallucinatory; they don't "count." If atomistic experiences are the grounding post for knowledge, then on what grounds can we reject some of these atomistic experiences: they are supposed to be the yardstick by which we measure knowledge, so what right could we possibly have to scrutinize them? Their credentials would be unassailable. We will return to the assailability of credentials later in this section, and to epistemic foundationalism in general in future chapters.

elements can only be spoken of significantly when certain 'point of view' has been established from which the elements can be designated as like or unlike" (Cassirer 1910, 25). Until we determine a perspective from which to compare, until we determine which properties are salient, we cannot compare objects. But abstraction theory sets up comparison as the first move in the game, thereby precluding any inquiry further back, into the nature of comparison itself. Similarity becomes an unexplained primitive, when in fact it was the very thing that we were hoping to have explained to us.[13]

The fifth objection regards different types of relations. Specifically, abstraction theory, with its characteristic structure of nested concepts, recognizes super- and sub-ordination as the fundamental relationships between concepts, and aggregation as the characteristic relationship between objects within concepts. These relationships, then, are forced to do yeoman's service in trying to account for mathematical concepts, which have a characteristically asymmetrical form.

Ultimately, class logic fails to live up to this challenge. How can we form the concept of a natural number? Even if we compare groups of four objects, and attain the concept of "4" by this comparison, there is still a crucial element missing. "It is a fundamental characteristic of the ordinal theory that in it the individual number never means anything by itself alone, that a fixed value is only ascribed to it by its position in the total system" (Cassirer 1910, 47–48). Each natural number is defined by its place in the total series of natural numbers, which is infinite. We could not achieve knowledge of an infinite series by abstraction, and could therefore never know any of its members.

Instead, we must begin with the function that generates this series: $S_{n+1} = S_n + 1$. The generation rule is finite, and simple, and grounds the entire infinite series, thereby grounding each of its particulars. Mathematics is a logic of serial relationality. Attempting to shoehorn mathematics into the mould of abstraction theory and class logic fails, because abstraction theory can't grasp the necessarily infinite nature of mathematics, and class logic deals with super- and sub-ordinate relations whereas mathematics deals with serial relations. Simply put, syllogistic logic should not be used to "derive" mathematics, because the two are on the same plane; the two types of relations are simply specific settings of relationality in general. Logic and mathematics are thus siblings, and their common parent is general relationality.[14]

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[13] For more details about the fourth objection, see (Cassirer 1910, 25, 337; 1929, 398; Gawronsky 1949, 221; Krois 1987, 108–109). For the relation between this objection and questions about induction, see (Cassirer 1910, 81; Ryckman 1991, 72). There are also parallels to be drawn to Plato's *Meno*, in which we encounter the paradox about learning from experience: if we don't already know what we're trying to learn, how can we recognize it when we see it? But if we already recognize it, we must already know it, meaning that there was no need to learn!

[14] For more information on the fifth objection, see (Cassirer 1910, 42–48; 1929, 367–369; Heis 2011, 4–5). The relationship between mathematics and syllogistic class logic is a topic of major historical interest in this discussion, as it was seen to be an important point of contention for Kant's Critical work. The Baden (a.k.a. Southwest) school of

"These same basic syntheses upon which mathematics and logic rest, also govern the scientific structure of empirical knowledge and first enable us, by a fixed lawful ordering of phenomena, to speak of its objective significance" (Cassirer 1907, 45; quoted in Ryckman 1991, 65). Given Cassirer's emphasis of the strong bond between mathematics and science, his theory about the formation of mathematical concepts will have direct bearing on his views of science. What we see here is that epistemological atomism is incompatible with the holism of mathematical and scientific concepts. Knowledge is holistic rather than atomistic; and because it deals with idealizations that can't possibly be derived from the outside world, the holistic system indelibly involves the mind. Taken together, these problems speak against any supposition of mind-independence.

Having now seen Cassirer's arguments against abstraction theory and atomistic epistemology, let's move on to Cassirer's positive account of mathematics and geometry.

§3.4 Cassirer's philosophy of mathematics and geometry

In the first objection above, Cassirer clarifies that concepts are not meant to distance us from reality, but are rather meant to present reality to us in sharper and sharper focus as science develops. "The genuine concept turns away from the world of intuition only in order to lead back to it with all the greater certainty: it serves to determine the particular itself" (Cassirer 1929, 309). What is this turning away from the world of intuition, and how does that world grow richer as a result? Following the then-recent developments by Dedekind and Hilbert, Cassirer argues that mathematics and geometry are constructive rather than abstractive. Mathematics gives us a rule for connecting particulars, showing them to be derived from a given law as one of its parameters passes through a continuous series of values. The particulars are thereby lawfully connected rather than simply aggregated: the particulars find their full determination through these laws, rather than being simply discarded by them as was the case for abstraction theory (Cassirer 1910, 20).

We thus have two correlate and codependent moments: particulars and laws. Donald Verene sums up the situation concisely and clearly:

> The mathematical concept of function is composed of two inseparable elements. One of these is the series of entities to be ordered as variables, the other is the law of their arrangement or the rule of succession. These

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Neokantianism adhered to a conception of class logic as basic, whereas the Marburg school, of which Cassirer was an important part, understood logic in a broader sense (Friedman 2000, 30). The tension described in this fifth objection therefore did not threaten the continuity between mathematics and logic as conceived by the Marburg school (Friedman 2000, 29). Also, "Kant und die moderne Mathematik" (Cassirer 1907) specifically treats Russell's recognition of the impasse between class logic and mathematics, especially as it pertains to the impacts on Kant's epistemological program in the *Critique of Pure Reason*. No complete translation of that essay exists, to my knowledge, though helpful discussions of parts of it can be found in (Ryckman 1991; Richardson 1998).

> two elements differ in kind, not in degree. Neither can be derived from the other, yet each is meaningless without the other. The law of arrangement or rule of succession has no meaning apart from what is ordered by it; in itself it arranges nothing. The variables it orders have no meaning in and of themselves; they only *are* something when they are determined to have a specific place in the series, when they are given membership in the series the law governs. (2011, 9–10)[15]

Thus, rather than beginning from given and grounded particulars, on the basis of which we determine conceptual connections through abstraction (all the while noticing that particulars are already grounded and fully determinate, thus rendering conceptualization entirely superfluous), Cassirer argues instead that particulars and laws/concepts arise together: the particulars as places in a series, and laws as the generators of those series. This argument problematizes any epistemological atomism, urging a turn towards holism.

For instance, the concept of triangle does not obliterate the differences between different triangles. Rather, those differences are conceptualized as arising from certain continuously variable parameters, which each individual triangle fills with its own values. Thus, a single triangle can stand for the whole class. Though the individual has the parameters of this function filled with particular values, it still stands as a representative of the function itself, which is common to all triangles. "What holds together the various structures which we regard as examples of one and the same concept is not the unity of a generic image but the unity of a rule of change, on the basis of which one example can be derived from another and so on up to the totality of possible examples" (Cassirer 1929, 291).

Cassirer endorses three elements of Dedekind's picture of mathematics: (1) the essential properties of numbers are relational. All numbers are defined by their relationship to other numbers within the same series, which is given by the same generation rule. Furthermore, different generation rules are also coordinated with one another through generation rules of higher order (e.g., mapping that allows us to understand the relationship between the functions of addition and of multiplication). Thus, through the coordination of generation rules, individual numbers are defined by their relationships to other numbers within their same series, and also to numbers appearing in other series with which they are coordinated at higher levels. (2) Given the generating rules, we can be assured of the existence of numbers. Their existence is determined by their relational properties, whether or not there are real objects in the world that correspond to them at the limit of approximation. (3) Because the nature of individual numbers is determined holistically by a relation to the total series, knowledge of all numbers comes simultaneously. We do not learn about one number, and then another, and a third, and then finally about the generative rule. Rather, knowledge of the generative rule grants us knowledge of all of its particulars at once.[16] And the purpose of the generative rule is to

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[15] For more details about the relationship between series form and series member, see (Cassirer 1910, 34; 1923, 22–39; Ryckman 1991, 67).

[16] For more details on these three elements, see (Heis 2010b, 771–772).

delineate such a series, having no other purpose, as we saw above in the quote from Verene. This is the epistemological holism mentioned above.

Concerns about necessity arise time and again when we derive rules from the examination of particular instances. Even if an operation has yielded the same effect in all observed cases, how can one be sure that unobserved cases will follow the same pattern? Such concerns do not arise in mathematics or geometry because we do not start from particular cases and attempt to build up a universal. Rather, necessity permeates these fields from the first because the particulars themselves are derived from their respective universals. The property of the sum of interior angles being equal to two right angles is a necessary property of all triangles, not because any number of specific triangles was shown to have such properties, but because it flows from the definition of triangles themselves. Similarly, we can be sure that parallel lines do not meet at infinity (in Euclidean space) not because we have actually examined all such cases, which of course we never could, but because parallel lines are defined this way from the outset. Particular cases are ordered and they are necessarily deducible by the laws that generate their characteristic series, in which particulars are but a location.

All of these deductive systems provide a standpoint from which to judge similarity and dissimilarity, to parse experience. "Every new standpoint (and the concept is nothing but such a standpoint) permits a new aspect, a new specific property, to become manifest" (Cassirer 1910, 224). Abstraction theories presuppose similarity and the grouping of particulars as a primitive and unproblematic act, which ultimately proved to be a source of major criticism, as we saw in the fourth objection above. Cassirer here wishes to show that constructive systems, such as mathematics and geometry, in fact provide the ground necessary to make those judgments of similarity and difference in the first place. They provide a perspective from which similarity and difference can emerge, delineating a bedrock of invariant parameters through which substantive variation can be categorized and unified, retaining difference rather than obliterating it as abstraction theory does.[17]

Recall the example of triangles being functionally unified despite variation in the values of their parameters (e.g.: length of their sides, measurements of their interior angles, etc.). Mathematics and geometry lay out the structural foundation whereby substantive variation can be unified. But in fact without this structural foundation from which to start, without parameters laid out beforehand, we could never judge similarity within the unbridled chaos of allegedly pure experience. It is only against this invariant background of parameters that variation in their values can emerge. Similarity and difference, just as chaos and order, are correlate moments that must arise together and be defined with respect to one another. None of these potential perspectives is "more true" than any other; none of them represents the phenomena more faithfully than any other.

This codependence of form and intuition, of course, flies starkly in the face of orthodox Kantianism. Kant himself posited a faculty of intuition and a faculty of the understanding. Spatial and temporal intuitions were supposed to arise without the help of

[17] For more, see (Ibongu 2011, 29).

the understanding, with Euclidean space and Newtonian mechanics as models of objective spatio-temporality. However, Kant's system was threatened in the late 19th and early 20th centuries by the development of non-Euclidean geometries, and especially by their physical application in Einstein's shining new theories of special and general relativity. Many saw these developments as sounding the death knell of Kant's system from the first *Critique*. The need to square Kant's theory with these developments was an important motivator for Neokantians, especially Cassirer himself. In fact, "Kant und die Moderne Mathematik" and *Substance and Function* are devoted almost entirely to this reconciliation attempt.

The reconciliation takes the following form: rather than substituting non-Euclidean geometry and relative physics into the corresponding slots for geometrical and physical theories in Kant's system, Cassirer instead restructured the system to accommodate the genetic development of scientific knowledge. Just as the points and lines of geometry take their definition from the laws in which they appear, being derived as given parameters pass through a range of variables, so too must the different scientific theories relate this way to the epistemological system. The understanding has a general function: to structure experience (Cassirer 1910, 68). Euclidean geometry provides one structural form; non-Euclidean geometries offer others. But there is no unformed, objective space to which either corresponds: such a notion would arise from atomistic intuition, which in Kant's system is the realm of pure intuition, unformed by the understanding. Cassirer rejects the intuition/understanding divide entirely (Friedman 2000, 28). All intuitions are now in need of some structuring from the very first, and no specific structure is primary or privileged (Friedman 2000, 26–27). In this way, Cassirer's epistemological system implicates the mind at every turn, speaking against any assumption of mind-independence: the structuring of the understanding is implicated in every intuition.

This is not a rejection of Kantianism, but is rather meant to be its further development. Cassirer identified much more strongly with Kant's transcendental method, inquiring into the necessary conditions of experience (i.e.: what it means for something to exist), than he did with the resulting system that Kant himself produced through the application of that method. We affect a *rapprochement* between Kant and Einstein, therefore, not by replacing the old science with the new. That would be simply to update the values of these different functions in Kant's system. Instead, Cassirer urges us to recognize that scientific knowledge is like a function, passing through a range of theories as the values of that function. In this way, he demonstrates the connection between knowledge and *all* scientific systems, rather than simply the scientific system that we happen to have at any given time. Non-Euclidean geometries and relative physics thereby possess no further threat to Kant.

Cassirer brings in empirical evidence to back up his claims against pure, atomistic intuition, specifically drawing on developments in group theory and psychological testing. Constancy of colour, shape, and size,[18] for instance, require the establishment of invariants before the experience of objects can take place. Those invariants, therefore,

[18] For Cassirer's discussion of these constancies, see (1944, 10).

cannot arise from experience itself. What are these constancies? We can recognize a surface as red, say, regardless of whether the light hitting it is white or yellow or some other colour. The wavelength of reflected light hitting our retina changes, so we don't have simply the same atomistic perceptual stimulus, but the contextualization of the stimulus within its surrounding environment allows us to cognize the colour of the surface anyway. The experience is product of the relationship between the stimulus and the invariants of context; experience is not caused by stimulus alone. These experiences are not produced in the mind by an independent, pre-formed world.

In short, red could not correspond to a specific wavelength, because different wavelengths will correspond with the cognition of red depending on context. Rather, red corresponds to a relationship between a wavelength and its environment. Similarly, we recognize the difference between distant, large objects and proximate, small objects, despite the fact that the two may produce the same size imprint on our retina. As Cassirer puts it:

> The essential conclusion to be drawn here is that perception in general is not confined to the mere *hic et nunc*. Perception expands the particular datum; it is integrated into total experience; and it is only in virtue of this integration that perception can exercise its proper function as an objective factor in knowledge. If perception were tied up with the flux of impressions, it would necessarily disintegrate; for each of these impressions presents size, shape, and colour of the object in a different way. … We do not apprehend the particular as mere 'existence,' that simple reality in which there corresponds a particular sensation to each particular stimulus. On the contrary, the apprehension of the particular *qua* 'existence' involves apprehension of the possibilities of transformation which it contains within itself. (Cassirer 1944, 13–15)

The particular alone does not represent an isolated particular in a *Jenseitswelt*, in a world "behind" our perception or on the other side of it. Rather, the particular appears in a context of possibilities, in a network of groups of possible transformations that delineate similarity and difference. Particulars appear from the first in the context of parameters, the different values for which constitute identity and difference. We are always free to choose a frame of reference to delineate similarity and difference, as there are no atomistic, independent, objective, pre-set similarities and differences out there in the world that our reference frames are meant to capture (Cassirer 1944, 7).[19]

Tying this point back to the context of vindicating Kant: space is not in itself either Euclidean or non-Euclidean, or any other particular way for that matter. Space always requires formation, but no particular form is privileged. There is no pure intuition of

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[19] Here we see a characteristic difference between Cassirer and ontic structural realism. The latter claim that there are no objects, and so must maintain that symmetry groups are features of structures, or that symmetry groups *are* structures. But some would object, claiming that in fact symmetry groups are features of objects. Cassirer gets the best of both worlds: because objects and structures are co-dependent, symmetry groups are features of both, in a certain sense.

objective space devoid of any conceptual shaping; space itself must always be shaped by the concepts of the understanding, and those cannot be stipulated by a pure intuition of objective space. The frame of reference cannot be imprinted by spatial intuition because even the most basic objects of experience already presuppose such a frame, which must be supplied by the mind (Cassirer 1929, 376).

A pressing problem here confronts us: if the world itself isn't any particular way devoid of our structuring, then how do we ground objectivity? Are we not here pitched into the void, subject to the worst kind of voluntarism whereunder truth is defined not only by what we believe but also by the systems that we *choose*? Surely the truth cannot be simply a reflection of our caprice.

> What way remains of grounding the concept, if we are to regard it neither as a copy of inner nor of outer being, neither the physical or the psychical? This question, however, which constantly presses to the fore, is only an expression of a certain dogmatic view of the nature and function of the concept. (Cassirer 1910, 35)

What grounds the objectivity of mathematics and geometry is not their object; they are grounded instead by their method (Heis 2010b, 784). Mathematical and geometrical systems are ways of having a world (Krois 1987, 121), and though they can delineate very different worlds—e.g., space as either curved or not—their method of delineation forms a common thread that runs through the history of mathematical and geometrical theorization. These theories all posit the same kind of relations between particulars: namely, particulars are each defined relationally to one another, and the laws of their generation contain the infinite series within them deductively, thereby first delineating the series, which is the characteristic task of such generation laws. The elements of theories thereby ground one another holistically, establishing a perspective from which a unified world can be gleaned (Cassirer 1929, 395–6). Thus, each theory is thereby internally stable.

But even if we grant this unity within a given theoretical system, how do we ground the unity of mathematics and geometry over time, as theories undergo radical change? They partake of a common *internal* grounding structure, but that leaves the question of *external* grounding still open. Cassirer argues that in fact an analogous grounding characterizes the relationship *between* theories as well, describing theories as having both an "upward and a downward direction" (Cassirer 1944, 31). New theories are justified by their ability to answer questions posed by the old theory; old theories are justified by the deeper understanding we have of them as a result of their being situated within the new theories. A theory is always justified by its ability to fulfill certain demands, and those demands arise from the old theory; and the old theory is reinforced by the deepening of its foundations, which are to be found in the successor theory. Successor and succeeded thus mutually support one another, existing in a dialectical relationship. Each theory solves the problems of its predecessor while also demanding more, and the fulfillment of that

demand by a new theory always reseats the old theory from which the demand originally arose.[20]

Thus, Cassirer has tied together the objectivity of mathematical and geometrical knowledge both synchronically and diachronically, within a given theory at a given time as well as across theories and through time. But does this knowledge correspond to reality, or could the whole history of mathematics be massively incorrect? Cassirer will reject any such questions about the totality of knowledge corresponding to a real world; knowledge is always within the world of experience, theories being intended to present a perspective from which the world of experience can be unified. If unification is successful, the task is accomplished and one need no longer ask about anything further. (Of course, this task is always in progress and therefore never complete or verifiable, as the total history of the world has not yet unfolded, but Cassirer's discussion of diachronic grounding is supposed to alleviate that pressure.)

We will return to the issue of unification towards the end of the next section. For now, however, let us discuss a concern raised by Richardson (1998, 137). What grounds the method of mathematics, what assures the necessity of deduction? Is mathematics grounded in itself, or by our psychology? In the former case, we end up in a free-fall towards Platonism. In the latter case, we end up reducing mathematics to a fact of nature, subject to all of our concerns and anxieties about such things. Were I forced to choose from these options, I would venture the speculation that Cassirer is likelier to fall into the Platonist camp (given his love for the great student of Socrates) than the psychologist camp (given his contempt for psychologistic readings of Kant[21]).

However, I believe that even these options themselves may be selling short Cassirer's philosophy of symbolic forms. The assumption that the method is grounded by, or even originates from, either the subject or the object already assumes a pre-defined and static delineation between these two. Cassirer himself rejects any such notion, seeing each symbolic form as drawing the subject–object division along a different path. I will say nothing more on this issue at present, but point the reader to Cassirer's discussions of the symbol and the phenomenon of meaning, which I will treat in §4.2.

§3.5 Cassirer's philosophy of natural science

Cassirer sees the role of natural science not as a faithful reproduction of a substantial and independent world, but rather as the instituting of lawful connections among phenomena, sewing them into an unbroken unity (Ryckman 1991, 70–71). Science is too holistic to support epistemological atomism; and it implicates idealizations too centrally to support the supposition of a mind-independent world. Mathematics, as the pure science of relationality, provides the conceptual tools with which to affect this interconnection, with its characteristic containment of the particulars within the universals. But as we saw in the previous section, the particulars are defined through laws, which we cannot derive

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[20] For more details on this dialectical back-and-forth, which Cassirer characterizes as both centripetal and centrifugal, see (Cassirer 1929, 392–404; Heis 2010b, 782).
[21] See, e.g., (Cassirer 1936, 59).

from the world alone. In mathematics, the numbers are not discovered individually and their laws arrived at by induction. Rather, the law, along with the entire series it delineates and all of the relational properties of each individual location in the series, comes at once. How could such a methodology find itself applied to experience of the phenomena? We may be willing to allow mathematics and geometry to freely construct their own concepts out of laws, which are primary; but surely the concepts of physics must conform to the phenomenal world that they attempt to sew together. Typically, we would say that the laws of physics could not precede their particulars; rather, the investigation of particulars allows us to formulate a law by induction.

But Cassirer takes issue with such a superficial description of scientific methodology, and believes that we must dig deeper in order to reveal the epistemological lessons that science has to teach us. Scientific experimentation always relies on measurement, and while measurement might seem a matter of course, unproblematic, it in fact contains the most important seeds of epistemological discovery.

What is it that we do when we measure? We quantify; we render the phenomenal in the language of mathematics. Recall the second and third objections against abstractionism, discussed in §3.3: measurement always presupposes the idealized form from the outset, and scientific laws are presupposed even in the simple act of measurement itself. The numerical value that results from a measurement situates the measured object within the mathematical realm, but there is always approximation in measurement as our instruments are always of a finite accuracy. And the instrument itself is never what we use to measure: we always substitute for the real instrument before us the ideal instrument, which is supposed to work in a particular fashion.[22] So even in the act of measurement, we already presuppose a set of ideal concepts, which real objects are claimed to approximate. It is this relation of approximation that links individual objects to the ideal order; and it is the interconnections of the ideal order that allow us to sew elements together into a thoroughly complete totality. "No scientific theory is related to these [phenomenal, sensuous] facts, but is related to the ideal limits, which we substitute for them intellectually" (Cassirer 1910, 130; see also Cassirer's discussion of "transubstantiation" in 1943, 378).

But possessing idealized mathematical concepts is not, on its own, sufficient to permit measurement. In fact, we need scientific laws as well. Take the mercury thermometer, for instance. We must assume that mercury expands in a linear fashion (an *exactly* linear fashion, in fact, until we have a more accurate instrument to tell us otherwise) in order to use it to measure the linear increase and decrease in temperature. We start out with a firm grasp of neither the expansion of mercury nor the changes in temperature, so we idealize the former and hold it constant in order to make of it a measuring instrument for the latter. How could we check if mercury expands in a linear fashion? We would need to be able to vary the temperature in linear fashion and observe the behaviour of the mercury, but we had no antecedent grasp of the changes in temperature (as opposed to perceive

[22] For more details, see (Cassirer 1910, 143–144; 250–254; Lewin 1949, 277–285; Ryckman 1991, 70).

heat, warmer and cooler, which is not yet quantified and this quantification is exactly what's at issue here). "That we reach laws by comparing and measuring individual facts, is now revealed as a logical circle. The law can only arise from measurement, because we have assumed the law in hypothetical form in measurement itself" (Cassirer 1910, 146); laws arise from measurements only because lawfulness was presupposed in the measurements to begin with.

Cassirer endorses Planck's dictum: "Everything that can be measured exists" (cited in Cassirer 1910, 357). However, due to the epistemologically complex nature of measurement, endorsing the measurable also requires endorsing the fundamental elements that make possible the very act of measurement, its necessary logical preconditions. Those preclude the possibility of a world that is either atomistic or mind-independent (or both).

To clarify what he understands by "reality," Cassirer distinguishes between three levels of statements in physical theory:[23] (1) statements of the results of measurement, (2) statements of laws, and (3) statements of principles. The results of measurements are characterized by their particularity, their attachment to specific spatiotemporal points, their individuality. Measurements are the alpha and the omega of science, because they are the bridge to the phenomenal world whereby the phenomenal can partake of the unity of the ideal concepts.[24]

But physics is never satisfied with particularity, and constantly seeks the mutual conditioning and interconnection of particulars. This is where the laws come in. "The mere 'here-thus' that is contained in the particular statements of the results of measurements undergoes a characteristic transformation in the statements of law: it is converted into an 'if-then'" (Cassirer 1936, 41). Generality as opposed to particularity is what differentiates laws from the results of measurements. Physical laws cannot be merely an aggregate of particular statements, as Galileo showed in his arguments against Mill. If the set of statements were infinite, then it would be impossible to verify, or indeed to construct in the first place. If the set of statements were finite, then it would be useless for the purposes of deduction, completely inapplicable to new cases (historical discussion treated in Cassirer 1936, 40). Laws are on a different logical level from the results of measurements, and cannot therefore be reduced to them, just as in the case of mathematics the law delineates the members of the series *but the law is not itself a further member of the series it delineates*.[25]

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[23] This whole discussion of levels is covered in (Cassirer 1936, chapters 3–5). Cassirer also already had the idea of these levels much earlier, in at least prototypical form, as he brings them up briefly in (1910, 359). See also (Kaufmann 1949, 196–7; Schmitz-Rigal 2009, 82–4; 2011, 26).

[24] This is what Cassirer means when he speaks of leaving the realm of the intuitive only to return to it with more vehement force. Passing through the realm of the ideal allows us to return to the intuitive and enrich it with a new unity, otherwise foreign to it (Cassirer 1910, 229).

[25] See also (Verene 2011, 9–10).

The particulars are situated by and within laws, and thereby find their grounding and legitimation. But "the first condensation of facts into laws had hardly occurred when the other, no less strong impulse [arose] to combine laws into principles and comprehend them as special cases of these principles" (Cassirer 1936, 45). Just as the results of measurements find their legitimation in laws, so too do laws analogously find their legitimation in the principles of which they are special cases. Whereas results of measurements are particular, and laws are general, principles are universal. Principles provide rules for seeking laws; they are not themselves laws. For example, Hero of Alexandria used the principle of least action to ground the law that light must travel in straight lines. This principle is conserved through the history of scientific development, and one sees it crop up again and again in the works of Fermat, Leibniz, Euler, Lagrange and Hamilton.[26]

Copy theories of knowledge attempt to shear off the logical differences between these three levels of statement. The fault of these empiricist theories is not that they see experience as the sole arbiter of truth, but that they begin with an overly simplified notion of what constitutes experience. Theories that rely on mind-independence overlook the necessarily idealizing function of the mind in co-constituting experience. Atomistic epistemologies attempt to derive this plurality of statements from those of a single level; they attempt to use the results of measurements as the solid edifice on which to construct laws and principles. But these statements are of different kinds, and passing from one level to another always requires a "jump," which cannot be neglected. To say that a small jump is practically no jump at all is little consolation. Instead, the mutual coordination of these statements is to be viewed as an organic totality.[27]

When pressure is exerted at any one point, it reverberates through the whole edifice, according to Cassirer's "principle of mutual limitation" (1936, 70; see also Schmitz-Rigal 2009, 84). A measurement that contradicts the theoretically derived value, for instance, either must be rejected or calls for revision of scientific law. A more serious incursion might even threaten a universal principle. No single element in this total system is beyond correction, but the structural integrity of the system as a whole is always safeguarded. The edifice can bend, but it will not break: without this guarantee, individual experiences would not even be possible, and so the fact of experience itself assures us of this structural integrity.

Whereas the individual is threatened in the abstraction theory by the universality of the concept, in which its individuality is lost, the individual in Cassirer's critical epistemology of science actually finds itself in its universal. The laws ground the particulars and show their particular determination; that's the very function of laws. Thus, the functional unification of the phenomena of light and electricity in Maxwell's electrodynamic theory, for instance, does not negate the reality of light or of electricity.

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[26] Cassirer discusses the details of this example in (1936, 47–48).
[27] See also (Krois 1987, 111).

Quite the opposite in fact: they both find their full determination by being mathematically unified.

Cassirer notes, in this context, that energism has a leg up on the mechanistic worldview: while mechanistic pictures seek to reduce all types of work to one type with a clearly sensuous meaning (thereby making one kind of work primary), energism seeks to reduce all kinds of work to a single quantificational value that has no single, immediate sensuous correlate. Thus, mechanistic worldviews threaten to reduce the three levels of statements, because they attempt to reduce a variety of sensuous concepts to one single sensuous concept, claimed to be basic. By contrast, with energism it is clear that the unifying feature is by no means sensuous. Energy is of a different logical level, and thereby need not threaten the legitimacy of the different types of work that we found grouped under its heading (Cassirer 1910, 200–201; Capeillères 2007, 358–359). The sensuously heterogeneous is homogenized through quantification and functional coordination, but this process reaffirms, situates and grounds the sensuous heterogeneity rather than denying it, and also without reifying it (Cassirer 1910, 213–214; 1936, 172–4; 1942, 320–321).[28]

Just as in the case of mathematics and geometry, the objectivity of science once again emerges as a pressing question that Cassirer must answer, as voluntarism and relativism lurk in the shadows of his theory. One notable difference, however, is that while we may be happy to allow mathematics and geometry to have free rein and define their objects freely, we expect physics to "save the phenomena," to do justice to sensuous experience. This is exactly its function, of course, and as we saw, it accomplishes the function of creating an organic whole of sensuous experience by coordinating it, through measurement, with an ideal order. Individual judgments, then, are objective not when they correspond to the way the "real" world is, beyond our cognition, but rather when they fit seamlessly into an experiential whole (theory and intuition interpenetrating), when they are able to stand as representatives for all times and places, possible as well as actual (Cassirer 1910, 243). Threads of experience are objective when they are woven seamlessly into the experiential whole; and theory is the weaver.

Once again, synchronically, this notion of objectivity seems unproblematic, as we routinely discuss the interconnection between different parts of theories from a given time. More problematic, however, is trying to assess the objectivity of a judgment at a given time in light of theoretical change in the past, and the reasonable expectation of theory change to come. Being able to ground a particular judgment by connection to a

[28] We find a similar situation presently with "wavicles," the entity that's supposed to have the properties of both waves and particles. The simple fact is that waves and particles have inconsistent properties. Cassirer's theory suggests that if we want to overcome the intuitive difficulty of grappling with this reality, and it is a difficulty felt by all students getting their feet wet in physics, what we need is a picture that leaves behind sensuous intuition entirely. We need to reconceive this topic, in a way as estranged from waves and particles as energy is from mechanistic motion; we need a conception of a different logical level.

whole theoretical paradigm may sound wonderful, but if we need to worry about the paradigm as a whole being rejected, then this type of theoretical connection seems to jeopardize our ability to judge the objectivity of any individual element within our scientific theories. And isolating the invariants of experience is a never-completed task (Cassirer 1910, 269); the danger of structural revision is very real.

So what safeguard do we have against the threat of theoretical revision? Here, as elsewhere, Cassirer draws on the distinction between series form and series member. Though a particular physical law may have its theoretical role adjusted, this is not a threat to its integrity within the system. A prime example of such retention is that the equations of Newtonian mechanics can be derived from those of relativity theory as the speed of the reference frame (or of the object) approaches zero.[29] Thus, the former equations re-emerge as we reach a limit value of one parameter in relative physics. The laws get re-seated, but ultimately remain within the system. The measurements, too, get re-seated, but ultimately not relinquished. What we relinquish is the ascription of absolute objectivity to one sedimented view of time and of space.

> This conclusion [about such conceptual revolutions threatening objectivity] is indeed unavoidable if we remain within the substantialistic viewpoint… However, the problem presents itself from an entirely different angle if the functional viewpoint is taken seriously. Then the multiplicity of answers to the question of 'being'—the nature and structure—of the atom is no longer objectionable. For a function *is* only insofar as it unfolds itself in a progressive series of values. It cannot be condensed into a single picture; but it includes all of its individual forms under a universal rule; it contains them as different cases of application. Not one of these applications is a final goal with which knowledge can remain satisfied. It is always only a milestone… If, in this progression, we can move in a single direction and be sure of it, we have in this direction and in it alone the criterion of truth… The representations fail—but the relations laid down in the statements of the results of measurements and laws remain in force, and it is these which form the ultimate foundation of physical knowledge. (Cassirer 1936, 149–151. See also Ryckman 181–182; Friedman 2005, 6–7)

What has happened here is that we have mistaken one series member, one value for a particular variable, as ultimate and beyond question. But so long as we recognize that it

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[29] There is a more detailed account to be given here. Strictly speaking, Newton's equations don't re-emerge as velocity goes to zero; they re-emerge when the velocity (V) divided by the speed of light (C) is much, much smaller than 1 (which of course happens when velocity approaches zero, but in other cases too). This explains why Newton may have arrived at his equations in the first place, and while we still actually use them today for many practical applications: so long as one is looking at objects/reference frames that are slow compared to the speed of light, Newton's equations are still accurate to an impressive degree. One only notices them breaking down when one starts looking at objects/reference frames that get close to the speed of light, when V/C approaches 1.

was a varying parameter all along, and that this theory is but one stage along a progressing series of theoretical development, then the threat dissipates.

Here we see the characteristic reaction by the three levels of statement to a perceived impasse. Measurements of the speed of light suggested that either the constancy of the speed of light, or the possibility to simply sum up velocities across reference frames, had to be relinquished. This tension was introduced when actual measurements again and again failed to corroborate the theoretically predicted values. Some shortcomings of measurement can be dismissed as the occasional aberration in experimental practice, but a recurring mismatch suggests a deeper-lying issue: a tension between, on the one hand, the simple summing of velocities across reference frames, rooted in the notions of absolute space and time; and on the other hand, the notion that the speed of light ought to be a constant, regardless of the conditions of measurement. Einstein's genius was that "he dared to give absolute priority to the conditions of the possibility of physics, even if this implied apparently 'unacceptable' consequences… The velocity of light *should* be a constant, independent of observational status, … the 'principle of relativity,' the claim that all inertial systems are equivalent, *should* hold" (Schmitz-Rigal 2009, 87).

The objectivity of science is grounded by the continuity within the three levels, despite pressures exerted upon the total structure in the course of experimentation. Radical discontinuity would not be possible, as experience itself just is the connection of particulars under concepts. But is any part of the whole completely immune to discontinuity? Not necessarily. Just because the total structure is thus immune does not mean that each of its parts must be as well. Sometimes we really do simply throw out data points as aberrations, experimental errors. Laws and principles could also be open to such drastic revision, again subject to the proviso that the total structure not undergo a radical discontinuity.

What of the objects of science? They are defined by the lawful series in which they appear, and as laws themselves are constantly unfolding through the course of the development of science, the completely determined scientific object can only constitute an ideal end point towards which we look but that we never in fact reach. Completely determined objects are therefore an ideal goal of science,[30] in opposition to abstraction theories and epistemic foundationalism, according to which the complete object sits before us from the beginning, our cognitive starting point. Recall here that the objects of science are not to be confused for the results of measurements. The results of measurements are particulars, and while they may be re-seated in theory change, they are still given to us as individual particulars within experience, embedded from the very first in theoretical relations. The objects of science, by contrast, are points of intersection within structures, only ever partially characterized at a given time by scientific theory.

[30] For more details, see (Cassirer 1929, 421; Gawronsky 1949, 223; Ibongu 2011, 23–24).

For example, the atom is not totally present to us, but only partially; but measurements of the atom's properties are individual, particular, and present within experience itself.[31]

In mathematics, we saw that the succession of theories is guided by a set of questions posed by the old theory, which are fulfilled by the new theory, which in turn grounds the former theory by deepening its foundations. In science, we have a similar situation. What are these questions; from whence do they arise? In natural science, questions arise from the following mantra: *plurima ex paucissimus*.[32] This mantra expresses a double tendency, a tendency towards expansion as well as towards compression. Science seeks to contain more and more particulars, to grasp an ever-greater portion of phenomenal reality; but at the same time it attempts to compress its theoretical foundations, deriving this growing set of particular measurements from a shrinking set of general laws and universal principles. This is the demand for simplicity in science, the principle of parsimony.

Tensions in the system of science could never arise if it rested satisfied with its present share of particulars. Recall that measurement is the alpha and the omega of science: if science ceased to expand its grasp of particulars, if it ceased to seek new measurements, then it could never be "disappointed" by the actual outcomes of these new measurements. The conceptual structure of science is forced to adapt in order to accommodate this ever-flowing influx of particulars. Sometimes that revision seems to decrease simplicity, swimming against the current of compression, the second half of the mantra. However, global simplicity must sometimes be purchased at the cost of introducing such local complexities, and it is the overall system that is guided by the principle of parsimony, not necessarily each of its parts individually at all times (Cassirer 1936, 85).

§3.6 Epistemological lessons from relativity theory and quantum mechanics

One of the most interesting aspects of reading Ernst Cassirer is his intellectual versatility. He draws deeply on the history of thought, not only from philosophy but also from a vast diversity of intellectual spheres, including poetry, linguistics, and the natural sciences. But beyond an awe-inspiring grasp of intellectual history, Cassirer was also corresponding with some of the most influential thinkers of his own time, including Martin Heidegger, Albert Einstein, and Niels Bohr. He was shockingly well versed in the developments of modern science (especially physics) from the 19th and 20th centuries, and the insights that he provided are still relevant today, many philosophers even now, with the benefit of hindsight, not grasping the full import of theories that Cassirer handled ably when they were still fresh off the press. In the present section, I'd like to discuss two physical theories developed during Cassirer's lifetime, relativity theory and quantum mechanics, that he believed held important lessons for epistemology.

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[31] As for the objects of sensuous reality, which approximate ideal concepts in measurement and are thereby connected to the ideal order, their status will become clear in §4.4.3.

[32] Or, "the most out of the least." Cassirer's treatment of this mantra is found in (1936, 66–70).

Relativity theory and quantum mechanics both presented major challenges to their scientific predecessors, and the adoption of each constituted a major revolution in scientific thought. From relativity theory, the threat to the objectivity of absolute space and time presented a major intellectual obstacle in light of its incompatibility both with Newtonian mechanics (which had reigned for centuries and is still regarded as one of the most impressively fruitful scientific theories of all time), and with our intuitive worldview according to which space and time are separate dimensions. From quantum mechanics, the conclusion that the world is not totally deterministic, as well as in-principle limitations on measurement, undermined our intuitive and theretofore scientific view that all objects have completely determined positions and momenta,[33] and that these facts and laws constituted a fully deterministic physical system.

In both cases, Cassirer diagnosed these existential worries as resulting from a stultification, a sedimentation, a substantialization of series members. It is a failure to recognize that theoretical continuity is functional rather than substantial or imagistic that leads to these worries about revolution and discontinuity. When we get too comfortable with a given theoretical picture, we begin to think that it mirrors a substantial reality beyond perception, rather than serving the objectifying function of creating phenomenal unity in the first place. A theoretical revolution re-seats former concepts on deeper foundations, which is completely understandable and acceptable to the functional view of epistemology, in which concepts are always grounded by their place in theory, and retained as special cases of the new theory.[34] But for copy theories of knowledge, this conceptual waltz can only be seen as threatening our most basic beliefs about the way the world really is.[35]

Let's begin with relativity theory.[36] The experiments of Fizeau and of Michelson suggested that light does not behave the same way in media at rest as it does in media in motion. But the laws of electrodynamics required that light have a constant velocity, regardless of the medium through which it moves. This feature of electrodynamics was in direct contradiction to the Galilean-Newtonian postulate that velocities in different reference frames can simply be added to one another. We end up here in a precarious

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[33] The relationship between positions and momenta is not unique. Rather, it is an example of a broader class known as "conjugate variables," where accurately knowing one of the two variables diminishes the accuracy we can have in knowing the other, and we are have no choice but to strike a balance. Each of these pairs threatens the notion that properties are fully defined at all times. I use position and momentum here because it maps nicely onto an intuitive picture of particles banging off one another deterministically like billiard balls, an intuitive picture that holds sway to this day in the lay picture of the world.

[34] We will return to this issue of theory retention explicitly in §3.7.

[35] See also (Schmitz-Rigal 2011, 30).

[36] Cassirer offers a comprehensive treatment of relativity theory and its impacts on critical epistemology in his essay "On Einstein's Theory of Relativity," originally written in 1921, but these days usually printed as an appended supplement to *Substance and Function*, at least in English translations. The material on which I'm drawing here is found in (1921, 358–381).

situation, with apparently three options. Either (i) the laws of mechanics or (ii) the laws of electrodynamics need to prove themselves to be superior, and thus relegate the other to rejection; or (iii) we need to relegate each of these fields to its respective corner and accept that they operate according to their own laws. Each of these options presents a threat to the unity of nature sought by science.

Einstein recognized here that a major problem with our conceptualization of reference frames was that we were treating the measurements as if they were *external* to the reference frames themselves, as if they were somehow standing on an objective dais looking in on the frames. In fact, the acts of measurement themselves and the instruments used are *within* those reference frames, and therefore subject to the same effects that the reference frame has on the bodies being measured. At that point, what was needed was a rule for figuring out how these reference frames relate to one another; Einstein borrowed this relation from the equations for the Lorentz-transformation, which afforded for the speed of light to be retained as a constant across reference frames without requiring the rejection of any laws of electrodynamics or mechanics. The Galilean-Newtonian hypothesis of simple addition emerges as a limit case of the Lorentz-transformation equations, specifically in cases where the velocity of the system and the object are not close to the speed of light (see footnote 29 above). The two principles of special relativity, therefore, are (1) that the speed of light is a constant in all reference frames, and that (2) all reference frames are equally permissible for the formulation of physical laws, that no reference frame can rightfully claim primacy.

The general theory of relativity is meant to accommodate systems that don't maintain a constant velocity, that is, whole systems that accelerate or decelerate. For instance, each of us has a certain mass, and when we stand on the Earth, the gravitational attraction between our mass and the Earth's mass creates a pulling force. This force is our weight, and it is pretty well constant all over the planet.[37] However, when we launch ourselves into space in a rocket ship, we talk about the strength of the "g-force," which is a multiplying effect that acceleration has on weight. So if weight is a combined result of masses and gravitation, and weight is also affected by acceleration, then (given that mass remains constant in this situation) there must be some equivalence or interchangeability of gravitation and acceleration. This equivalence is exactly what the general theory of relativity describes, and it therefore allows us to functionally unify two sensuously distinct phenomena: gravitation and acceleration. We can equally well unify our measurements by supposing that we are in an accelerating reference frame with no gravitational force, as by supposing that we are subject to a gravitational force within a reference frame at rest (Cassirer 1921, 401).

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[37] Of course, the distance between our centre of mass and that of Earth is also implicated here, so as we move to higher and lower elevations, there are miniscule changes in this distance. However, because those changes in elevation are so tiny relative to the average radius of the Earth, our weight is basically constant so long as our mass remains the same.

Recall that the first principle of special relativity is that the speed of light is constant across all reference frames, regardless of velocity or acceleration. Given the lesson from general relativity above, that gravitation and acceleration are simply two faces of the same coin, we now see that general relativity adds the further stipulation that the velocity of light is also relative to gravitational fields we encounter within space. The gravitational conditions of space must therefore also be taken into account whenever we take a measurement. This not so much negates the validity of the special theory of relativity as rather reaffirms it all the more as a limit case of the general theory of relativity: the special theory emerges at the limit where changes in gravitation reach zero.

Wesley Salmon offers a charming and very illustrative anecdote that can help us to understand the workings of the general theory of relativity, of unifying acceleration and gravitation (1989, 183–185). Once upon a time, a friendly physicist was in an airplane awaiting takeoff. Sitting across from the physicist was a small child, whose father had wisely provided her with a balloon so as to keep her calm during the flight. The helium-filled balloon bobbed up in the air, entrancing the little girl who was tied to the other end of the string. The physicist leaned over the aisle, and asked the girl, "When the plane takes off, which way do you think that the balloon will move?" After a moment of intense brow furrowing, the little girl replied, "To the back of the plane!" The physicist said, "Well *I* think it'll move towards the *front* of the plane." The little girl's father and the flight attendant had both overheard this exchange, and were intrigued. The steward even wagered a drink that the balloon would float towards the back as the plane took off. But when the plane took off, the steward was shocked and the physicist enjoyed the fruits of her correct prediction.

Why did the balloon move towards the front of the plane? Two explanations can be offered here. The first is that the molecules of air in the plane all had a certain inertia, and when the plane began to accelerate, those molecules resisted the acceleration to the best of their abilities. However, as the plane moved forward, the molecules collided against the back wall of the cabin, and were reluctantly brought along with the plane's motion. As these molecules gathered in the back of the plane, they created a gradient of pressure peaking in the back and dipping in the front. This pressure gradient exerted greater force on the back face of the balloon than it did on the front face, forcing the balloon forward. In short, there were more molecules in the back of the plane pushing the balloon away than there were in the front. Because the helium in the balloon was so light, this back-side pressure was sufficient to move the balloon forward.

The second explanation draws on the equivalence of reference frames, and the functional unification of acceleration and gravity. Rather than picturing the plane as subject to uniform gravitational forces and beginning to accelerate, we can imagine *the plane sitting still* in *a reference frame that's accelerating*. In this scenario, there is a gravitational well that builds up, emanating from the rear of the plane. Because the molecules of air are heavier than the helium, they are pulled more strongly towards this gravitational well, and as they push and shove their way towards the back of the plane, the helium balloon is forced forwards.

Salmon here argues that we have two distinct scientific explanations, both of which are correct (1989, 183). Following Cassirer's lead here, I would argue that in fact we have two *intuitive* explanations, but only *one* underlying scientific explanation. The sensuously distinct is functionally unified through a common set of equations, and we therefore need not concern ourselves that in fact two different scenarios are at work here. There may be some concern that in fact we are not drawing on the same principles, that causal/mechanistic explanations, such as the first explanation, arise from different sources than do relativistic explanations, such as the second. To those concerns, I would respond that in fact scientific explanations require not merely a linguistic gloss, but that we must actually dig into the nitty gritty of the mathematical equations to offer a scientific explanation. Recall that science lives and dies by measurement, according to Cassirer's theory; what would be needed for a strictly scientific explanation would be a measurement of the phenomenon and its relation to scientific laws.[38]

The true insight of relativity theory is that "no sorts of *things* are truly invariant, but always only certain fundamental relations and functional dependencies retained in the symbolic language of our mathematics and physics, in certain equations" (Cassirer 1921, 379–381; my emphasis). What relativity theory shows us is that objectivity pertains to showing how different measurements can be fit together into a harmonious whole, not to demonstrating a correspondence between perception and a mind-independent, substantialistic world. So when Einstein proclaimed that space and time had the last remnants of their objectivity swept away by relativity theory, this can only have meant "objectivity" in its former, substantialistic sense. In fact, relativity theory reaffirms the *critical* objectivity of space and time more than ever before: they become necessary factors to take into account for every single measurement (Cassirer 1921, 412)!

Relativity theory, therefore, must not be confused with relativism. Relativism would force us to accept that there is no single truth, that there are only individual truths corresponding to the different and incommensurable frames of reference in which they arise. The power of relativity theory is to resist any such incommensurability. Yes, measurements always arise *within* the conditions of a frame of reference and so no measurement is ever totally objective on its own; but they arise in accordance with laws that hold *across all* reference frames, and these laws allow us to tie such diverse reference frames together into a coherent whole. Here we once again see the characteristic correlation between variation and invariants. In fact, because of the misleading association between "relativity theory" and "relativism," it has been suggested that relativity theory ought actually to have been called "invariant theory" (see, e.g., Schmitz-Rigal 2011, 31).

In addition to the supplemental essay on relativity theory published in 1921, Cassirer published in 1936 a complete book on the epistemological import of quantum mechanics, entitled *Determinism and Indeterminism in Modern Physics.* This work picks up on an

[38] Cassirer's notion of explanation here would be far closer to Kitcher's unificationism than to Salmon's causal/mechanical picture. The fact that both Cassirer and Kitcher take their lead from Kant, the proximity of their views is no coincidence.

idea that Cassirer first expounded in *Substance and Function*: the causal principle, that like causes bring about like effects, can only be fulfilled (or falsified) once we have adopted a specific definition of similarity and difference from which to begin (1910, 249). Quantum mechanics was, and still is, seen by many as the conclusive refutation of the causal principle, and Cassirer's project in 1936 is to examine whether that refutation is as conclusive as it might at first seem.

Cassirer begins by discussing Laplace's demon,[39] which has captured imaginations to such a degree that is has seemingly become synonymous with determinism itself. According to this famous thought experiment, we are to imagine a great demon who has knowledge of the position and momentum of each particle in the universe at a single time, and knowledge of every scientific law (from the ideal, "complete" science, not merely any present science). This demon, then, presumably with the help of some equally demonic super-computer, would be able to calculate the position and momentum for every single particle in the universe, forwards and backwards, throughout all time. The demon would have complete knowledge of all physical facts. However, the quantum revolution made life difficult for our kindly old demon, because the laws of quantum mechanics make it impossible to have completely accurate knowledge of the position and momentum of the same particle. So the demon can no longer make the predictions that our previous science once suggested were possible; the world must no longer be deterministic, no longer governed by the causal principle.

Cassirer here asks a pivotal question: the demon is said to have complete knowledge of all physical facts at a given time, but how does he come to have such knowledge? Either he just receives it intuitively, in god-like fashion; or he actually goes out and measures. If his physical knowledge is direct and intuitive, god-like, then what need has he for calculation? He has no need of scientific theories because his knowledge isn't theoretical. He doesn't actually calculate anything because it's already before his very eyes! But on the other hand, if he actually needs to go out and measure these physical facts, then he is subject to the same limitations of accuracy that we are. The demon therefore cannot serve as our ideal of knowledge, either because the ideal is completely different in kind from our own knowledge (which is necessarily theoretical), or because his knowledge is similar in kind to ours but therefore not ideal. The worry, then, that quantum mechanics makes the Laplacean demon unable to calculate the past and future exhaustively and conclusively, need not concern us. And we need not worry that determinism has been thereby undermined. Rather, the demon himself has been defanged, thereby calling for a fresh interpretation of the causal principle.

Cassirer believes that the apparent problem for determinism arose when the causal principle itself became too closely identified with a particular type of law, characteristic of classical mechanics but no longer appropriate in the quantum context. Again, "like causes" and "like effects" require a definition of similarity and difference to have determinate meaning (Cassirer 1910, 249); the fact that quantum mechanics rejects the idea of *one particular definition of causes and effects* cannot on its own indict the causal

[39] The discussion of Laplace's demon is found in (Cassirer 1936, 3–24).

principle. In its most general form, the causal principle is simply a call for order among the phenomena; it's a demand for a delineation of similarity and difference, and an unequivocal coordination between similar antecedents and consequents.

As such, the causal principle is actually a transcendental principle of cognition, a necessary precondition without which experience would not be possible. It is the demand:

> that the phenomena of nature are not such as to elude or withstand in principle the possibility of being ordered by the process we have described… it says that these [statements of the results of measurements, laws, and principles] can be so related and combined with one another that from this combination there results a system of physical knowledge and not a mere aggregate of isolated observations. (Cassirer 1936, 57–62)

The causal principle is a statement of a fourth level (Ibongu 2011, 90–93), just like the principle of parsimony, *plurima ex paucissimus*. These two, together, form the demand that is to be met jointly by the three levels of statements: experience is to be ordered into a physical system, and the system is to be completely exhaustive while maximally simple.

But this general demand for order is not to be confused with any specific shape for that ordering, drawn from science at any given moment. The failure of any given scientific law should not threaten causality in general, for three reasons. First, the three levels of statement guarantee the ever-greater fulfillment of the principles of causality and parsimony; they don't guarantee the absolute retention of laws, i.e., statements of the second level. Second, we know that the demands of the predecessor theory justify the adoption of its successor, and the successor retains its predecessor by explaining its success. And third, we know that no experience is possible without a demand that cognition itself must fulfill. In short, there could be no experience that "breaks the machine" of the causal principle, because the causal principle itself (understood in its proper generality) plays a fundamental role in delineating what experience is. No single experience could "break the machine" of experience as a whole, because it is only through the machine that single experiences gain their validity. How could any counter-example to all experience, therefore, stake claim to its validity? Thus, the crisis for causal determinism prompted by the quantum revolution was in fact a crisis for a particular worldview, not for the causal principle in its general form, as a transcendental principle (Cassirer 1936, 163–164).

The main tension introduced by quantum mechanics arises from the use of statistical laws, which were seen to run counter to the deterministic laws of the orderly universe. How could science proceed with this fracture of two different types of laws threatening its demand for unity?

> Dynamical and statistical laws were not regarded as two complementary methods and directions, as two different modes of description; they were instead opposed as the 'determined' and the 'undetermined.' Thus the new problems that were introduced by the second law [of thermodynamics] and by the development of quantum theory were discussed under the heading of 'indeterminism,' a title which gave rise to the most dangerous

> equivocation. It seemed to open the doors to… a state of freedom which was hardly distinguishable from caprice. (Cassirer 1936, 89)

But probabilities do not destroy objectivity, they do not contravene the causal principle: rather, they affirm it all the more because they are derived deductively from determinate laws and magnitudes (Cassirer 1936, 90).

At first, it was believed that dynamical (as opposed to statistical) laws formed the fundament of reality, a view according to which statistical laws could be seen only as incomplete representations of deterministic reality. Exner attempted to invert the priority, positing that statistical laws were fundamental, with dynamical laws emerging as macroscopic limit cases. Concomitant with that inversion was the view that individual quantum events formed the fundament of reality, and that because these could not be mapped with certainty, but only probabilistically, the universe must in fact be radically chaotic (Cassirer 1936, 81).

In fact, though "determinism" and "chance" are sensuously distinct, they can be functionally unified. Expressing the chances of an outcome using probability notation, we see that "deterministic" systems always have a probability outcome of 0 or 1. By contrast, the probability of "chancy" systems always falls between those two values, but never exactly at either limit. That is to say, "chancy" systems always output a probability within the set]0,1[. But because mathematics allows us to functionally unify the number continuum, the endpoints can be numerically unified with all the values that fall between them. Thus, because "deterministic" and "chancy" systems can be numerically represented, and their numerical values can be demonstrated to be continuous, we are able to functionally unify the sensuously disparate phenomena of deterministic and probabilistic causation. This solution to the apparent incommensurability is my own development, not to be found in Cassirer's work but inspired by it.

Cassirer presents a different solution to the problem of dynamical and statistical laws, instead focusing on the objects related by those laws. His solution draws on the work of von Mises, specifically the latter's notion of relative frequency: relative frequencies, which are derived from statistical laws and measured magnitudes, refer to the proportions one would find in an infinite set of experiments. For example, when we calculate that the half-life of radium-226 is 1601 years, this conclusion means that given an infinitely large set of radium-226 isotopes, half of that set would have decayed into radon gas after 1601 years. "In a certain series of events the relative frequency of occurrences of an event approaches a definite limiting value as the number of observations increases indefinitely" (Cassirer 1936, 94–96).

Copy theories of knowledge have cause to worry about such infinite sets, because they are ideal objects and never encountered immediately in experience. However, they pose no problem for Cassirer's critical epistemology, occupying the same role for statistical laws that frictionless planes and rigid measuring rods play for dynamical laws: they are merely the ideal objects that the real approximates, and the act of measurement is simply a judgment to validate the approximation of the real to the ideal.

Once again we see the dependence of objects on measurements, and the interdependence of measurements and laws. The discrepancy between statistical and dynamical laws is not that only one type but not the other fulfills the principle of causation: they both do. And neither one nor the other gives a "more complete" description of reality: each delineates a fully determinate reality, which we see to depend on the conditions of measurement. It just so happens that they delineate different ideal objects; "individual" occurrences according to classical mechanics only seem "chancy" in quantum mechanics because quantum mechanics traces its "individuals" differently. Those individuals are infinite sets, but the probability distribution of those sets is totally deterministic. And neither classical mechanics nor quantum mechanics is free of the need to idealize; each has its characteristic ideal objects that the real approximates at the limit.

We can now come back to Heisenberg's uncertainty principle and the Compton effect (both discussed in §3.2) to revisit the problem in light of the critical theory of epistemology. Cassirer agrees with Heisenberg that we should not look for information beyond what our science tells us is possible to measure. The uncertainty principle, therefore, expresses the upper limit of quantum physical knowledge *because that principle plays a partially constitutive role in what counts as a quantum physical fact* (Cassirer 1936, 125). In this instance, Cassirer agrees with Bohr's reply to the famous Einstein-Podolsky-Rosen article of 1935.[40] According to that infamous triumvirate, if a property can be measured without disturbing the system, then the property is real. Positions of particles are measurable; therefore they are real. Momenta of particles are measurable, too; so they must also be real. But if both position and momentum are real, and quantum mechanics imposes a limitation on our ability to know them, then quantum mechanics must be incomplete. Bohr responds that we can measure position *or* we can measure momentum, *but not both*. In fact, digging deeper into the problem, we see that the Einstein-Podolsky-Rosen condition of reality cannot be fulfilled: we cannot measure *either* momentum or position without disturbing the system in question.

Heisenberg goes on to argue that this limitation on our knowledge constitutes a refutation of causation. He interprets the causal principle as meaning: "If we have exact knowledge of the present, we can determine the future" (Heisenberg 1927, 197; quoted in Cassirer 1936, 123). Because we can never have exact knowledge of the present, as our accuracy is limited by the uncertainty principle, then the antecedent of the causal principle can never be fulfilled. However, let us examine this argument more closely. Why can we never have complete information? Because the uncertainty principle, a regularity of nature, shows such knowledge to be inaccessible. But that regularity, the lawfulness on which the uncertainty principle reposes, is actually the critical sense of the causal principle. Heisenberg has shown that *one particular form of regularity* is problematic, but had to rely on *another form of regularity* to do so. Thus, he has not threatened the critical sense of causation, which is the assertion of lawfulness in nature; instead, he has only reinforced it.

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[40] These two classic papers are well worth the read, and both appear in Cassirer's bibliography a year later when *Determinism and Indeterminism* appears. See (Einstein, Podolsky and Rosen 1935; and the response, Bohr 1935).

Here is the relation between Cassirer's position and those of the great physicists discussed in the preceding paragraphs. Cassirer sides with Bohr's view that the real conditions of measurability should define reality, acknowledging that measurement in the realm of quantum mechanics by necessity affects the system itself and thereby imposes a limitation on accuracy. We should therefore not assume that quantum physics is incomplete. We are not able to trace the exact position and momentum of a given particle at all times, but to assume that there is such a value at all times is nothing more than an assumption carried over from classical mechanics and the intuitive worldview (where the assumption still holds true, by the way; see Cassirer 1936, 192). However, this "limitation" on our knowledge, which actually arises because we are importing assumptions from one knowledge system into the other, does not express incompleteness of information. Therefore, Cassirer disagrees with Heisenberg's assessment that quantum mechanics undermines the causal principle: firstly, because Heisenberg himself relied on the possibility of lawful derivation to ground the very principle of uncertainty that he used to demonstrate the limitation of our knowledge; and secondly, because the objects that quantum physics does set up for itself are simply different in kind from classical objects, though the objects of each is idealized and so confirm the same underlying epistemological lessons.[41]

Schrödinger proposed the following dilemma (1935; treated in Cassirer 1936, 115): either statistical laws are incomplete expressions of a determined reality, or the appearance of deterministic necessity is merely an illusion, resting on a bedrock of random occurrences. The problem with each of these views is that it assumes from the outset what counts as an occurrence, whereas in fact dynamical and statistical laws are both deterministic relative to the objects that they describe.

Cassirer thus dissolves the apparent incompatibility of statistical and dynamical laws by appealing to the different types of objects that they delineate, and describing their shared function of world-building; I suggested above that the dynamical and the statistical could also be unified functionally by demonstrating their numerical continuity, as expressed in probability notation. My response, though not endorsed or apparently even considered by Cassirer, is not meant to be a rival or alternative solution. Rather, I see my proposal as complementary to Cassirer's own. We both conclude that these two types of laws are unified; but whereas he describes that as a unification via epistemological function, I describe the unification "further along" in the system, as it were, demonstrating the numerical continuity between their computed outcomes.

Cassirer will also use his critical epistemological edifice to define observability: what is observable is not at all independent of our theoretical constructions. Rather, those constructions themselves define the limits of observability, with Heisenberg's uncertainty principle standing as a paradigmatic example of science describing the limits of the observable. When we denounce belief in the unobservable, therefore, it must be recalled

[41] For some lovely and unequivocal quotes on Cassirer's position here, see (1936, 185; 188–189). He also would reject all hidden variable theories (see footnote 6).

that the sense of "observability" will be different for Cassirer than it would be for, say, the constructive empiricist.

> Is there any sense in ascribing to [electrons] a definite, strictly determined existence, which, however, is only incompletely accessible to us? Or must we not rather take the opposite path—must we not take seriously the demand that we use the conditions of the possibility of experience—that is, the conditions of accessibility as conditions of the objects of experience? Then there will no longer exist an empirical object that in principle can be designated as utterly inaccessible; and there may be classes of presumed objects which we will have to exclude from the domain of empirical existence because it is shown that with the empirical and theoretical means of knowledge at our disposal, they are not accessible or determinable. (Cassirer 1936, 178–179; see also Heis forthcoming, 23)

Once again, as in the case of relativity theory, the true epistemological value of quantum mechanics is that it has forced us once again to reflect upon the significance of measurement in the construction of empirical reality, and specifically the logical preconditions of measurement itself. Measurement cannot be atomistic in the sense of naïve abstractionism, as the theories of relativity and of quantum mechanics demonstrate unequivocally.

§3.7 Cassirer's relationship to ontic structural realism

We now have in hand the basics of Cassirer's philosophy of concept formation, mathematics, geometry, and natural science. We're finally at a point, then, where we can turn back to ontic structural realism to assess their incorporation of Cassirer's conclusions into their project. Namely, Ladyman et al. express the hope that Cassirer's structuralism (especially regarding aspects of modern physics) can be detached from his Neokantian epistemology. Sadly, they offer no instructions for how this extraction might take place. I think, though, that we can conclude quite safely that these hopes are in vain. Cassirer's structuralism arises from his diagnosis of scientific concept formation and application; however, those same diagnoses suggest an epistemological holism, and furthermore that the mind is actively involved in the constitution of the world at each stage of this whole, namely in idealization. Cassirer definitely does not support structural realism. And furthermore, his structuralism arises from the same source as his epistemological commitments, and thus cannot be plucked from that larger edifice. Establishing whether such a division is possible was a major goal of this chapter, and I consider that goal to now be achieved.

But if this division indeed isn't possible, and Cassirer's structuralism therefore can't be of any service to structural realism, then how did we end up in this predicament? Why did the potential alliance show promise in the first place?

Both Cassirer and ontic structural realism argue against the primacy of objects over structures. Neither wishes to endorse an ontology of self-subsisting objects, on whose properties structural relations are merely supervenient, laid upon the objects after the fact. Recall that ontic structural realists are unclear on their views regarding particulars: they

either want to reject particulars entirely; or if particulars are to be retained, they must be secondary to structures.[42]

Looking back at Cassirer's arguments against abstraction theory, surveyed in §3.3, it is clear that rejecting particulars outright is not a viable option. The first argument against abstraction theory is that as concepts become more and more universal, they progressively abandon particularity. Scientific concepts, to which Cassirer is attempting to do justice in his arguments against abstraction, are supposed to deductively retain the particulars under them as one ascends to more and more universal concepts. One of Cassirer's main arguments against abstraction theory is that it fails to retain particulars, so clearly this argument would also speak against ontic structural realism for the outright rejection of particulars. Cassirer and ontic structural realists share the goal of rejecting the Aristotelian picture of substance, but the avenue Cassirer takes to get there implicates the mind in a holistic epistemology, thereby precluding both epistemological atomism and the mind-independence of the world.

Let's turn now to Cassirer's positive project. In place of the Aristotelian picture of substances and abstraction, Cassirer articulates his picture of the three levels of statements in science: results of measurements, laws, and principles. Recall that these three levels are interdependent, that none is prior to the others or primary. Given this interdependence, Cassirer's positive project is surely also incompatible with ontic structural realism, which calls for either the rejection of particulars, or at least the primacy of structures over particulars. If Cassirer is to be aligned with any position in the realist camp, he seems to sit most comfortably with semirealism, given its characteristic view of the codependence of structure and particulars.[43]

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[42] See my comparison of ontic structural realism and semirealism in §2.6. Semirealism clearly endorses the equiprimordiality of particulars and structures (i.e.: that particulars and structures are equally ontologically basic) whereas ontic structural realism is unclear on this point. If ontic structural realism can tolerate equiprimordiality, then semirealism is actually a position *within* ontic structural realism, rather than an alternative. However, for the sake of clarity, let us continue to treat semirealism as a position distinct from ontic structural realism. The latter is aiming to endorse either the rejection of particulars or at least the primacy of structures; semirealism, by contrast, endorses equiprimordiality.

[43] An objection leveled by semirealism against ontic structural realism is that it leaves no room for the changes in the universe that we see around us at every moment (Chakravartty 2007, 77–78). The universe is clearly not a static place, but ontic structural realism seems saddled with claiming that it is. Perhaps their recourse is to argue that change is a mere illusion, but that doesn't seem very satisfactory. In any case, we can now diagnose the source of this problem: change takes place in the particulars that appear in structures, which provide the background of constancy. Again, the correlate moments of variation and invariants solve this problem, and by emphasizing invariants and rejecting entirely (or at least downgrading) that which varies, ontic structural realism unsurprisingly ends up not being able to account for the change that we see in the universe around us.

Another problem for ontic structural realists is that they must give an account of how we come to learn about structure. Ladyman and Ross note that particular observations, such as flashes on a scintillation screen resulting from the impact of electrons, are merely heuristics. Once we have used these particulars to attain knowledge of structure, we dispose of the particulars, kicking out the ladder from under us once we've reached the structural plateau above (2007, 154–155). However, the conceptual move from particulars (even as heuristics) to structural relations seems to be nothing but abstractionism all over again, and Cassirer argued vehemently against that![44]

Cassirer's arguments against abstractionism till the soil for his structuralism, which stipulates a codependence of structure and particulars. Ontic structural realists wish to sidle up to his structuralism, while not taking seriously the codependence. Furthermore, they wish to do so while retaining an abstractionist view of concept formation. Put simply, they wish to retain his conclusion, but only the structuralist part of it, all the while paying no attention (and actually falling victim) to the arguments that he uses to motivate those conclusions in the first place. In what sense whatsoever, then, are these "Cassirer's" ideas that are being brought into service for the ontic structural realist cause?

In his second and third arguments against abstractionism, Cassirer discloses the fundamentally theory-laden and idealized nature of scientific experience. In short, it is not possible to arrive at concepts such as frictionless planes or perfectly round spheres by abstraction, because there are no such things out there in the world. Furthermore, we cannot say that the world's objects approximate these things, at least of their own accord, because it is only in virtue of having these ideal conceptual elements *beforehand* that the real can be compared to them. Lastly, every measurement, every act of judging the real to approximate an ideal element, requires idealization as well as the positing of certain physical laws. These arguments speak not only against abstractionism, but also against any form of epistemological atomism or mind-independence. We never have a solid grounding post in experience, something transcendentally justified and assured to which we might tie our theories. No experience in science is independent of theorization or of idealization. Therefore, we shouldn't look to isolate different elements of science, or to subsequently identify which parts stand upon those solid posts of a mind-independent world.

As Heis notes, the opposition to abstractionism and the transcendental method are argumentatively linked (2011, 34). Once we reject the notion of building up knowledge completely from scratch on the basis of certain indisputable facts justified *externally*, we are left in a position of always trying to build knowledge from *within*, always rebuilding

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[44] Skepticism also lurks in the shadows here. Cassirer responds to two types of skepticism, ancient and modern. Ancient skepticism doubts that we can ever reach the real substance underlying experience. Modern (Humean) skepticism doubts that we can ever trace real relations between objects. Cassirer handles both. Ontic structural realists counter Ancient skepticism by denying underlying substance, instead reifying structural relations. But in so doing, they impale themselves full-force on the skeptical concerns about causal relations, so famously associated with Hume. See (Ibongu 2011, 85–86).

the ship on the high seas. The task of knowledge, then, becomes the sewing together of experience into a consistent and organically unified whole, rather than justification of theory by any external standard. So the arguments against abstractionism have even further-reaching consequences: rather than merely suggesting that particulars and structures must be correlate moments (which would appear to support semirealism), the necessity of positing ideal structure and scientific laws in order to measure also suggests the impossibility of epistemological atomism and forces one towards epistemological holism,[45] and ultimately Cassirer's own critical epistemology.

This position completely undermines the supposition of a *Jenseitswelt*, a substantial, mind-independent world somehow beyond/behind our perception, that is the ultimate arbiter of truth for realist and empiricist positions. Truth is rather something within experience; objectivity is the coherence of parts of experience in an organic whole. Realist and empiricist doctrines all begin from a mind-independent world (disputing where to draw the line for epistemological endorsement of our scientific theories); and so the entire debate is jeopardized by this conclusion of Cassirer's arguments. Cassirer undermines all positions in this debate, and is to be identified with none of them. This leaves the debate in a precarious position, and it seems that anyone wishing to revitalize it will need to address, in a principled fashion, either why Cassirer's arguments against abstraction should not be allowed to leave the station in the first place, or why we should get off the train before it reaches the terminus of holism and critical idealism.

§3.8 Mopping up, and moving on

Here we reach the completion of the first half of the present project. I originally set out to elaborate the realist–empiricist debate, and use Cassirer's relation to structural realism as an opportunity to throw into question that debate as a whole. This phase is now complete; but I do not wish for the present work to be solely a destructive undertaking, and so we will shortly embark on a constructive course, exploring how Cassirer proposes that we revise our views about the world. Specifically, if the world is *not* out there, finished, merely reproduced in experience, then how *is* it; and from this discussion what do we learn about ourselves, as experiencing subjects? This question we will answer in the coming chapters, through an exploration of the full philosophy of symbolic forms.

It may seem tiresome to continue flogging ontic structural realism at this point, but some further concerns regarding that position, as it shares some of the structuralist features of Cassirer's own critical epistemology of science, will be worth mopping up. First, the division between mathematics and physics presents a challenge for ontic structural realists. They are not able to answer concerns about the murky division, but they remark that Cassirer also blurs the line between mathematics and physics, given that elements in each are defined through the relevant universals (French and Ladyman 2003, 41–45). However, that's not quite fair to Cassirer. He definitely sees both as inherently structural, but mathematics and geometry are allowed to be completely free constructions, answerable only to the methodological demands of their respective fields. By contrast,

[45] See, in following chapters, elaborations of why even a coherentist or conventionalist epistemological picture cannot satisfy the holism that Cassirer's arguments demand.

physics must "save the phenomena" by structurally binding them through their approximation of ideal structures (validated through measurement).[46] This response is not open to the ontic structural realists because they have denied the reality of the particular phenomena in the first place, recognizing only structures as real. But while Cassirer has certainly affected a *rapprochement* between mathematics and physics, I think it's unfair to characterize his theory as blurring the line between them.

This process of saving the phenomena, of course, is an unending one, because the phenomena are constantly being unfurled through the passage of time, the course of experience itself. As discussed, the objectivity of physics is guaranteed by the three levels of statement, taken together, fulfilling the demands of the principle of causality and the principle of parsimony, *plurima ex paucissimus*. This epistemological structure constitutes Cassirer's response to the Pessimistic Induction. The Pessimistic Induction, we will recall, is the recognition that past scientific theories have all been rejected, and on that basis the conclusion that present science will likely be rejected as well. Structural realism counters this concern by limiting commitment to only the structure picked out by our theories, rejecting the particulars within those structures as the source of all theoretical shortcomings; accompanying that limitation is the promise that structure *will* be retained in cases of theory change, by at least partial isomorphism.

How do these two responses to the Pessimistic Induction fare relative to each other? Structural realism clearly stands or falls by the fate of mathematical equations: if they are retained, at least as limit cases, then structural realism fares well. If, however, these equations are rejected outright in the course of scientific advance, then structural realism is rejected along with them. In the case of Cassirer, if the equations (i.e.: laws, statements of the second level) are retained, he too fares well. However, if equations are rejected, his epistemological theory can survive yet a while, because the statements of the first and third levels may yet provide the necessary continuity. Results of measurements, laws and principles *taken together* must underwrite the continuity of science, but that need not imply that each of the three elements is continuous for all time.[47] Cassirer therefore fares better than structural realism against the Pessimistic Induction: the continuity of laws would serve both parties quite well, but only Cassirer has a further fallback position.

The interrelation of the three levels of statements, the formation of scientific concepts, and the validation of theory by experiment: these are all intertwined issues for Cassirer, and they form an organic totality. There is no power structure within this totality; no one aspect rules over the others. The same cannot be said for the ontic structural realists, according to whom laws are primary. One might rightfully wonder how, then, according

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[46] See, for instance, (Cassirer 1910, 166; 1929, 406–407; 1936, 195–196). On potential concerns about dualism, see §4.4.3.

[47] Michael Friedman, when discussing theoretical convergence for instance (2003, 21), sometimes speaks as though Cassirer *must* be committed to the continuity of laws as well. Cristiane Schmitz-Rigal, by contrast, seems quite clear that only the continuity of the three levels together is needed to ground objectivity (2003, 17; 2011, 26; 2009, 18; 2011, 36–37; see also Cassirer 1936, 56; Krois 1987, 111; Ibongu 2011, 77).

to the ontic structural realists, experimentation could ever falsify a theory. If equations and structure are primary, and particulars are merely heuristic illusions emerging from structure, then what right do particulars have to call structures into question? It seems, then, that scientific theory would survive all experimentation and never suffer rejection, which is quite to the liking of the structural realist, but only because theory itself is impervious to the potential threat of experiment. The truth of theory becomes guaranteed *a priori*: and that's anathema to realism of any sort, because science was supposed to map the realities of the mind-independent world, and the world was supposed to arbitrate between true and false theories.

What has gone so terribly wrong here, that Cassirer's theory shows structural realism to have such deep-seated problems? Cassirer's arguments against abstractionism specifically target a particular kind of epistemological atomism, namely, atomism about particulars. Atomism about particulars is equivalent to the reification of statements of the first level, the results of measurements: if you believe that the results of measurements are completely atomistic and beyond dispute, that these are the grounding posts for the objectivity of any theory, then Cassirer's objections from §3.3 target your theory directly. In this case, all theories are justified only by being borne out in experiment, and a single experiment would be sufficient to disprove a theory. This view is akin to Popper's falsificationism, or at least the dramatically simplified version of his theory that one often encounters. But the view that experimental results are beyond reproach, that they are never rejected, is patently contradicted by the practice of science. As Chakravartty puts it, having learned his lesson from Kant: "In order to distinguish between veridical and non-veridical sensory experience, one invokes theoretical beliefs, … the concept of individuality is theoretical" (2007, 75).

Ontic structural realists have recognized and appreciated (to an extent) Cassirer's arguments against the reification of statements of the first level. But instead of following Cassirer in resisting reification altogether, they have just gone on to reify statements of the second level. Thus, just as naïve abstractionism makes particulars completely unassailable, ontic structural realism makes structures completely unassailable. However, this is to once again fail to learn the lesson that Kant attempted to teach: neither the varying elements nor the invariant structures of experience are (or correspond to) objects of the *Jenseitswelt*. These elements and structures exist on different logical levels, serving different but entirely codependent (world-building) purposes.

Correspondence theories always go wrong in imputing a hierarchical primacy to one of these levels and assuming that the most primal element refers to a world beyond experience (Cassirer 1910, 166; 1929, 299–302; Lewin 1949, 281; Friedman 2000, 97; Schmitz-Rigal 2009, 83). Semirealism imputes primacy not to either of the first two levels, but to a harmonious co-constitutive relationship between them, which it substantializes. However, it still overlooks the third level of statements, as well as the epistemological role of the causal principle and the principle of parsimony, which are all fundamental to Cassirer's system of critical epistemology. The most notable feature here is that Cassirer rejects any kind of epistemological foundationalism, including the supposition of a mind-independent world, and such a mind-independent world is still an

active ingredient in the semirealist's recipe; Cassirer is thus closer to semirealism than to any other position on the realist–empiricist spectrum, but it's important to keep in mind that he still shouldn't be identified with semirealism, despite some similarities.

Cassirer's theory, here, shows its power in being able not only to solve epistemological riddles, but also to diagnose the causes of shortcomings in other theories. These other theories become limit cases of his own theory, as we inadvertently substitute a particular value for the variable functional parameter *for which* it is a value. The positions on the realist–empiricist spectrum therefore provide the demand that critical epistemology must satisfy, much like Newtonian mechanics and Maxwell's electrodynamics provided the demand ultimately satisfied by Einstein's theory of relativity. Similarly, Cassirer's theory subsumes the realist–empiricist spectrum, learning its lessons but acknowledging its ultimate rejection.

All of the positions on this spectrum begin with an assumption from the outset, be that assumption about the divide between the mind and the world, or the unproblematic nature of the given, where the given is taken sometimes to be atomistic sensations and sometimes to be objects in the world (Cassirer 1910, 390–391; 1929, 326; 1942, 326–327; Smart 1949, 257–258). Individual experiences are representative, but what they are thereby able to "stand for" is the *totality* of experience, not a substantial world beyond it (Cassirer 1910, 282–284). But there are many ways to divide the subject from the object, and many ways that a given perception may stand for the totality of experience: science presents just one method of sewing together the world into a consistent whole. Just as the progress of science justifies each step along its way, as the whole function has no meaning except for the infinite domain of values through which it runs, so must science itself be taken up as but one value for a continuously varying parameter.

In the same way that Newtonian mechanics is properly seated when it emerges as a limit case of relativity theory, so too must science find its justification in the same fashion: through a relativity theory of experience. Once again, as in the case of Einstein's relativity theory, the etymological similarity should not suggest that we are lapsing here into relativism: we are not relegating the truth of science to its own corner. Rather, that notion of truth will be properly situated within an invariant theory of experience that holds *across* knowledge systems, just as relativity theory in physics shows us how different frames of reference are to fit together rather than keeping them radically separate. Each tonality of world-making, of which science is but one, must find its proper place in a broader harmony (Cassirer 1910, 446–447; 1929, 383–384; Krois 1987, 106–8; Friedman 2000, 98–102; 2005, 11; Capeillères 2007, 324; Schmitz-Rigal 2009, 91; Verene 2011, 11).

Whereas scientific realism reifies one particular form of knowledge, the plurality of knowledge must be exposed in its *functional* unity, lest relativism set in beyond the scientific domain (as is characteristic of naturalism). Our criticism, leveled at the heart of the realist–empiricist dispute in science, was the first step in overcoming this naturalism; it was necessary to argue against the positing of a substantial, mind-independent world as the arbiter of truth. Now that this argument has been carried out in the context of science,

it can serve as a model for carrying out analogous arguments in other domains. However, such analogues will not be articulated here. Instead, we will explore Cassirer's proposed revision, as it will show us an alternative conception of the subject–world relationship, one according to which each form of knowledge can assume its proper place, with none dominating the others. This positive purpose of our project can be carried out only through an exhaustive examination of Cassirer's invariant theory of experience, the philosophy of symbolic forms.

CHAPTER FOUR

§4.1 Some quick history lessons

Following up on the demand with which the preceding chapter closed, let us now explore Cassirer's invariant theory of experience, his philosophy of symbolic forms.[1] Cassirer is often referred to as a Neokantian, and to grasp the import of his work requires understanding his fidelity to as well as his departure from that tradition. To see him strictly as a Neokantian will surely produce an inappropriate understanding of his work, as Cassirer himself explicitly acknowledges in his foreword to *Determinism and Indeterminism in Modern Physics*. To fully grasp Cassirer's relationship to Neokantians, one must understand how exactly they were influenced by Kant. But Cassirer's relationship to Hegel is also very important, and was for some time overlooked though that is starting to change. So let's try to clarify this situation by quickly retracing the historical developments from Kant, through Hegel, to the Neokantians, and ultimately to Cassirer.

Kant's infamous *Critique of Pure Reason* was a major step forward in the development of philosophy. In trying to address Cartesian and Humean concerns, Kant brought about a major revolution in the way that we look at epistemological problems; instead of starting from a fully formed subject and/or a finished, given object, and thereafter inquiring into how those two things can relate to one another, Kant began from the relation itself and then inquired into the nature of the subject and the object as the relata. That is to say, rather than asking whether subjects could have knowledge of the world, and trying to prove that we could (or could not), he instead asked about this thing we call "knowledge" and inquired into what that means. Hume raised doubts that our experiences correspond to something external, objective, and real; Kant just looked at the experience itself, specifically the experience of knowledge, and used that as a starting point for learning about cognizing subjects and their cognized worlds.

So Kant began from cognition, scientific knowledge, but he asked a very specific type of question about that cognition: what are the conditions of its possibility? In particular, how is it possible that we could have the experience of this kind of physical world? What must subjects and worlds be like such that this epistemological experience is a possibility? This is the question that Kant attempted to answer in his *Critique of Pure Reason*. In his *Critique of Practical Reason*, he attempted to answer the analogous question about moral experience; and in the *Critique of Judgment*, he attempted to answer the analogous question for ends or purposes, specifically as they figure in biology and aesthetics. In all cases, though, the critical question, the transcendental question, is to ask about the conditions of possibility for a given type of experience. This type of questioning shifts the direction of philosophy in a subtle but important way, investigating the significance

[1] For more on the philosophy of symbolic forms as invariant theory, see (Ryckman 1999, 614; Friedman 2005, 11; Skidelsky 2008, 123–124).

of knowledge rather than its causal genesis (PSF III, 58).[2] As elements or contents of experience, causation and teleology can only oppose one another, each claiming completeness and leaving no room for the other. By contrast, as modes of knowledge, they can stand as two ways of constructing a world, each fulfilling the same world-building function but each in its own way.

In the years that followed, Hegel looked at Kant's system and saw no place for the living, evolving forms of culture. Kant's analysis seemed sterile and dead to Hegel, who sought to revivify the "dead bones" of logic (Cassirer 1950, 2). He therefore sought to elaborate a philosophy that could make sense of the unfolding of culture in the history of humankind, in the real lived experience of subjects rather than only in the soulless realm of pure logic. This system is known as the "phenomenology of spirit," presented in a major work by that title. We can understand the meaning of "phenomenology" here by breaking the word down into its parts: "phenomenology" in this sense is literally the *logos* of the *phenomena*, the rhyme and reason of the appearing of these forms of culture; it's an attempt to elaborate and explain the unfurling of culture, how one form proceeds from those before it, and the way that these are interrelated. Spirit is dialectical, for Hegel; each thesis eventually encounters its antithesis, and they ultimately are taken up (or *aufgehoben*, to use Hegel's language) in a synthesis of the two positions, where this synthesis resolves the prior tension. This synthesis, in turn, becomes the new thesis, eventually encountering its antithesis and being synthesized, and so on. According to Cassirer's interpretation of Hegel, culture ultimately leads to a final culmination in the Absolute Idea, which "absorbs and reconciles all differences within itself" (Cassirer 1950, 274).[3]

Hegel was perhaps right to want sterile Kantian analysis enlivened, but much of Kant's fruitful insight into the natural sciences had been sacrificed. In the latter half of the 19th century, though Hegel's system had led to an undeniable gain for the *Geisteswissenschaften*, there was a general feeling that absolute idealism could not do justice to the natural sciences, which led to a strong resurgence of interest in Kant's work, a sense that absolute idealists hadn't given Kant's work due consideration before jumping on the Hegel bandwagon (Cassirer 1950, 3; Verene 2001, 10). The following dates should give a loose sense of the timing of this whole process. Kant published his first *Critique* in

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[2] Please note that here and after, *The Philosophy of Symbolic Forms* will be shortened to "PSF" followed by a Roman numeral indicating the volume. Pagination refers to the English translations, as documented in the full bibliography below. Also, given the importance of these works, I will always list them first in lists of references, followed by other works in chronological order.

[3] Current discussions of Hegel's work suggest that the thesis and antithesis are in fact not "reconciled" in the synthesis, at least in the sense of some sort of resolution of tension (see, e.g., Krahn 2014). However, this short characterization, caricatured though it may be, will suffice for the present purposes; as we shall see, Cassirer urges that the tension between thesis and antithesis must be preserved, and so if the current discussions of Hegel's *Aufhebung* preserving difference are correct, the result would only be that he and Cassirer are in fact more alike than my presentation would suggest.

1781; Hegel published the *Phenomenology of Spirit* in 1807; Hermann Cohen, a leading Neokantian,[4] published his commentary on Kant's first *Critique* in 1871. But to go back to Kant's epistemology of physics in the late 19th century was no easy task: specifically, Kant had taken as a given that Euclidean geometry and Newtonian physics were something like final theories, that they were not going to be overturned. The proliferation of non-Euclidean geometries, and ultimately their practical application in Einstein's relativity theories, made a straightforward return to Kant's doctrine impossible.

However, the Neokantians envisioned no such simple return, for they saw the kernel of Kant's brilliance in the methodological shift that he had brought about, the advent of transcendental analysis, examining the conditions of the possibility of experience.[5] Accordingly, Neokantians sought to undertake a fresh transcendental analysis. Hermann Cohen, Paul Natorp, and their Marburg school of Neokantianism sought to produce a transcendental analysis of the changing face of science. That is, they wished to investigate how scientific revolutions are possible, and what those revolutions disclose to us about knowing subjects and about the world we study. Cassirer was a student of Cohen and Natorp, and his earlier works are closely in line with the objectives of the Marburg school. His later works, however, show just how much Cassirer grew beyond Neokantianism, despite remaining loyal to their guiding insights.

Verene divides Cassirer's work into four periods (Verene 2001, 9–37), which we will quickly canvas now in order to help situate our present investigation of the symbolic forms project. The first period runs from the start of Cassirer's career, in the last decade of the 19th century, until about 1920; this phase covers Cassirer's studies at Marburg and his subsequent employment at the University of Berlin. It was during this period that Cassirer was the main editor of the new series of critical editions of Kant's works. In 1918, Cassirer made an important and original contribution to Kantian scholarship, *Kant's Life and Work*, which canvases Kantian thought as a whole as well as arguing for the importance of the third *Critique* as the key to understanding Kant's ideas. Also during this first period, Cassirer published the first three volumes of his *Erkenntnisproblem*, in which he traces the philosophical problem of knowledge from the beginning of the Renaissance up to Hegel. Cassirer's focus on Kant and on the problem of knowledge reached its peak during this period, culminating in the publication of *Substance and Function* (1910), which is perhaps the best and most thorough articulation of Marburg epistemology.

The second period of Cassirer's work spans the 1920's. During this time, Cassirer took his first crucial step beyond his Marburg colleagues. One of his first pieces of work to be published during this time is the long essay on Einstein's theory of relativity, intended as a supplement to *Substance and Function* and these days often printed along with it as a

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[4] Cohen was the founder of the Marburg school of Neokantianism. The other major school was the Baden, or Southwest, school. For more, see (Friedman 2000, chapter 3).

[5] On the primacy of Kantian method over doctrine, see Chapter 5, as well as (PSF I, 22; PSF III, 7–10; Hamburg 1949, 91; Swabey 1949, 123; Stephens 1949, 153; Werkmeister 1949, 794–795; Krois 1987, 114–120; Verene 2001, 10–17; Ikonen 2011, 200).

single volume. This supplement is meant to show how Einstein's work provides further confirmation and clarification of Cassirer's critical work on science, his Marburg work, and provides the first clear impetus to situate his thoughts on science within a broader philosophical context. This broader context is provided by *The Philosophy of Symbolic Forms*, the first three volumes of which appeared during this period, in the 1920's.[6]

The third period runs from the late 1920's until about 1935. During this time, Cassirer published another trilogy, this time about the development of the philosophic spirit as part of culture: *The Individual and the Cosmos in Renaissance Philosophy*, *The Platonic Renaissance in England*, and *The Philosophy of the Enlightenment*. In this period we also find *The Logic of the Cultural Sciences*, and works on individual thinkers such as Descartes, Rousseau, Kant and Goethe (whom Cassirer always read as having important philosophical contributions to make, and highly revered). The ethos of this period was to show the connection between philosophy and the cultural milieu in which it arises, and to disclose self-knowledge as the aim of philosophy, thereby tracing the tradition back to its Socratic roots.

The middle two periods of Cassirer's thought developed while he worked at the University of Hamburg, where he was engrossed by the Warburg Library. His relationship to Aby Warburg and his cultural library were instrumental in Cassirer's development of his theories of myth and culture. Cassirer also became the rector at Hamburg, becoming the first Jewish person ever to hold such a position in Germany. The fateful encounter with Heidegger at Davos also took place during the third period of Cassirer's thought, in 1929.

The fourth and final period of Cassirer's work spans from 1935 until 1945, when Cassirer died suddenly on the campus of Columbia University, from a heart attack. Cassirer had fled from Germany in 1933, when Hitler and the National Socialists rose to power, originally going to London (where the Warburg Library was also relocated). In 1935, he moved again, this time to Göteborg, Sweden, where he taught for 6 years. In 1941, Cassirer accepted an offer, arranged by Charles Hendel, to come to America and teach at Yale University, from 1941–44. Cassirer's final year, 1944–45, was spent teaching at Columbia.

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[6] A fourth volume was partially completed while in exile in Sweden, in the 1930's, but remained there when the Cassirers fled to America, only finally getting published when his wife, Toni Cassirer, returned to Sweden in 1946 and collected Ernst's papers. The fourth volume started out as a conclusion to PSF III, but eventually grew in size and importance to the point that Cassirer finally published PSF III without it, and resigned himself to producing an additional self-standing volume (see PSF IV, x). John Michael Krois and Donald Verene took it upon themselves to pull together the threads of those papers and edit them into a usable text, publishing the reconstructed work first in German, and then translating it for publication in English. Thora Ilyn Bayer's commentary is helpful in clarifying Cassirer's position. Further work clarifying Cassirer's arguments in favour of that position would be helpful.

This final period of Cassirer's work was understandably marked by his exile from Germany. It is often remarked that Cassirer's work lacks an explicitly ethical dimension; while that may be true of his earlier work, this final period of his thought seems permeated with ethics, most evidently in his book on Axel Hägerström's expressivist ethics, as well as in the last book he ever wrote, *The Myth of the State*, in which Cassirer diagnoses the cultural roots and philosophical implications of Nazi totalitarianism. Cassirer's works from this time argue with a certain urgency (which was quite out of the ordinary, given his normally calm and conciliatory character), coming back again and again to the relationship between freedom and culture, the criticism of one-sided metaphysics that establishes one cultural facet as primary and dominant over the others, and the role of philosophy as the watchman of culture. The criticism of one-sided metaphysics arises as a recurring theme in the fourth volume of *The Philosophy of Symbolic Forms*.

I hope that this short overview of the literature will prove helpful to those endeavouring to study Cassirer's works. But, of course, I must get back now to the task at hand. From this division, we can see that the third chapter of this dissertation coincides roughly with Cassirer's earliest work, with his Marburg period. The major focus there is on the problem of knowledge, on science, on *Substance and Function*. Already, though, we see that our treatment of the essay on Einstein, and of *Determinism and Indeterminism in Modern Physics*, is pulling us into Cassirer's symbolic forms phase.

Here we can gather up some observations from the history from Kant to Cassirer, as well as the layout of Cassirer's works throughout his career. Cassirer had an appreciation for Kantian analysis, the transcendental method inaugurated by the *Critique of Pure Reason* and applied more widely in the two later *Critiques*. But how do these realms of experience relate to one another, how are they interconnected? Here we see Cassirer's appreciation of Hegel's dialectical method, which drives the unfolding of spirit; Cassirer argued that the moments of spirit could not be properly understood if they were left to stand on their own and had no relationship to one another. Cassirer appreciated the renewed critical vigour of the Marburg school, but believed that giving a transcendental analysis of the unfurling of science was insufficient on its own; science itself is but one mode of experience, and each of those modes would be baseless without a phenomenology to situate them with respect to one another.[7]

However much Cassirer appreciated the brilliance of Hegel, there are still two important points of divergence to be noted here:[8] first, Cassirer disagreed with Hegel's logicism, denying that the moments of spirit can be arranged in linear fashion, that we might speak of "progressing" through these stages towards the absolute idea (PSF III, 54). Hegel

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[7] On the need for a phenomenology, see (PSF I, 77–84; PSF III, 16; Hamburg 1949, 92; Krois 1987, 106; Verene 2013, 40).

[8] For more on these two differences between Cassirer and Hegel, see (PSF I, 34; PSF III, 54; PSF III, 78; Cassirer 1927, 416–417; 1949, 875–876; Hartman 1949, 312; Leander 1949, 344; Verene 1969, 35–42; Krois 1987, 78–92; 1992, 443; Verene 2001, 20; Bayer 2008, 102–103; Skidelsky 2008, 105–108; Verene 2011, 18; 2013, 36–39).

argued that the tension between thesis and antithesis is resolved in the synthesis. Cassirer took a different path, claiming that each moment of spirit has its particular character and value; the tension between these moments must not be resolved through the phenomenology, it must be preserved! Thus, Cassirer rejected this interpretation of Hegel's famous *Aufhebung*.

The second point of divergence has to do with the role of myth. Cassirer maintained that myth is a fundamental moment of spirit that must be accounted for, and he therefore began his own phenomenology one step earlier than Hegel had.

Cassirer's first task is to carry out a transcendental analysis of the major functions of spirit, to outline the conditions of possibility for the major moments of culture. This task he accomplishes in the following texts: *Substance and Function* is his major work in outlining the conditions of the possibility of science. That is his most important grounding post within the Marburg school, both chronologically and thematically. The supplementary essay on Einstein as well as *Determinism and Indeterminism in Modern Physics* both serve to further clarify the foundational arguments that he laid down in *Substance and Function*. Science is one major cultural moment, and Cassirer identifies two others: language and myth. He lays out the conditions of possibility for language in *The Philosophy of Symbolic Forms, vol. 1: Language*. The conditions of possibility for myth Cassirer lays out in two works, *The Philosophy of Symbolic Forms, vol. 2: Mythical Thought* and the very brief *Language and Myth*.

Having completed his Kantian, transcendental analysis of each the three major functions of thought, Cassirer embarks on *The Philosophy of Symbolic Forms, vol. 3: The Phenomenology of Knowledge*, in which he takes up the Hegelian, dialectical aspect of this project. Now that he's got the conditions of possibility for the moments of spirit, Cassirer's third volume shows how those moments fit together and develop dialectically out of one another. Without this kind of dialectical exposition, the forms would merely stand side by side, leaving us totally unable to understand the relationships among them.[9]

As for the fourth volume, *The Philosophy of Symbolic Forms, vol. 4: Metaphysics of Symbolic Forms*, which Cassirer left unfinished amongst his papers in Sweden, what task was left to be accomplished? Here the Kantian and Hegelian projects come together once again. Having elaborated the conditions of possibility for each of the three cultural moments in *Substance and Function* and the first two volumes of *Symbolic Forms*, and having articulated their phenomenology in the third volume, the fourth volume then gives a transcendental analysis of the dialectic. That is to say, the fourth volume explores the conditions of the possibility of the phenomenology itself. This is quite a tangle, so I'll try

[9] Nelson Goodman embraces a similar plurality of forms of worldmaking, but offers no phenomenology, and therefore no way of fitting worlds together. See (Krois 1987, 12; 1987, 140; 1999, 555 footnote 5; Luft 2005, 19; Krois 2011, 11). It is also worth noting that while Cassirer's third volume details the development of spirit towards science, this direction is not the only one possible. One could equally well give a phenomenology of art, for instance.

once more to clarify this point: we know the conditions of possibility for each form, and we know how they emerge from one another and interrelate, but what we discover in the fourth volume is the conditions of possibility for that dialectical emergence. It might therefore also have been titled *The Critique of the Phenomenology of Spirit* (Bayer 2001, 191–193).

With this brief historical and thematic outline of Cassirer's work now in hand, I propose that we press on. The main purpose of this chapter is to explore the symbolic forms project, and how that project relates to our overall exploration of the realist–empiricist dispute. The first thing that we'll need is (§4.2) a set of definitions for the central notions of the symbolic forms project, which will give us the tools necessary to unpack (§4.3) the three major symbolic functions and the categories. With that material on the table, we can then retrace (§4.4) the phenomenological development from myth, through language, and into science. With that task accomplished, I'll present a brief sketch of (§4.5) the Kantian–Hegelian knot that is *The Metaphysics of Symbolic Forms*, raise and address (§4.6) a few concerns regarding Cassirer's whole edifice and its implications, and finally conclude the chapter with (§4.7) some observations about our progress in addressing the realist–empiricist dispute.

§4.2 The symbol's the thing

As we saw in the last chapter, in §3.4 specifically, Cassirer and the Neokantians took issue with Kant's rigid distinction between the sensibility and the understanding. In short, Kant posited that pure sensation comes to us completely unformed by concepts. But something was needed to bridge the gap between the purely sensuous and the purely conceptual; for Kant, this role was filled by the transcendental schema. The schema is a two-faceted artifact, something with a sensuous facet and a conceptual facet, allowing it to play a mediating role between these two realms, which would otherwise remain radically estranged from each other.

The notion of the schema consumed Cassirer, and came to centrally occupy his theorization. His fascination with and adoption of the schema come with a characteristic adaptation. Kant arrived at his notion of the schema by analysis: he recognized that concepts and intuitions do not remain fundamentally estranged from one another, prompting him to recognize the need for a mediating term. For Cassirer, the inherence of the conceptual in the sensuous (and vice versa) is an immediate phenomenon; we recognize it right away, because we always live in meaningful worlds. The significance of an experience is not something tacked on after the fact; it's already there from the start, our experience is always already conceptualized in some way. Gestalt psychology provides a plethora of examples of this notion. For instance, with the famous duck-rabbit illusion, we always see the image as either the rabbit or the duck. We can switch back and forth from one to the other, but the image will always take on *some* meaning.

Cassirer himself presents the example of a simple line drawing, or *Linienzug* (PSF III, 200–202; Cassirer 1927, 414–416; Verene 2011, 13–14). Imagine a squiggly line drawn on a page. We can regard it as an aesthetic expression, with each sweep of the line expressing a certain character of the artist, a playfulness or anger or what have you. Or

we can regard it through mythic eyes, seeing in the line a delineation between sacred and profane space, two spaces in which different rules apply. Or, yet again, we can regard it as a purely mathematical object, setting it within a Cartesian plane and establishing the function that determines its particular shape. All three of these are possibilities; in each of them we see the sensuous (i.e.: the ink of the line) imbued with a different meaning. But though there may be variation in the particular meaning that attaches from one moment to the next, the inherence of meaning within the sensuous is always visible. That's what the *Linienzug* example is meant to illustrate.

This inherence of meaning in the sensuous is Cassirer's symbol, his adaptation of the schema: whereas the schema was for Kant a necessary addition to bridge the sensuous–intellectual gap, the symbol is actually a phenomenon for Cassirer. The symbol is something that appears; we can actually look at the inherence of the meaningful in the sensuous. The schema is something that Kant knew must be lurking in the shadows. The symbol is something that Cassirer shows to be out in light of day, theretofore hiding in plain sight.[10]

There is one further aspect illustrated by this example, a crucially important aspect to recognize in order to grasp Cassirer's departure from Kant as well as from the Neokantians. The *Linienzug* shows us that we live in a world of symbols, that the sensuous is always meaningful from the beginning. But it also shows us that these meanings are not always scientific! Because meaning can come in different forms, e.g. the mythic and the aesthetic, the symbol provides the universal medium whereby all different kinds of experience can be set on the same footing. In all areas of experience, regardless of time, place, culture, etc., the constant feature found in all cases is that meaning inheres immediately in the sensuous. The symbol is the union of sensuous and meaningful (PSF III, 100; Cassirer 1927, 412; Hamburg 1949, 95). It is the fundamental invariant, the key to the universal account of experience.

Through the symbol, the critique of reason becomes the critique of culture.[11] This shift represents a significant step forward from the doctrines of Marburg Neokantianism (Werkmeister 1949, 792; Schmitz-Rigal 2009, 75). Cassirer does not expand the theory of knowledge; he subsumes it (Krois 1983, 151; 1987, 44; Schmitz-Rigal 2009, 91). This subsumption is a key step in the attempt to reconcile artistic with scientific experience (and with all other kinds as well). Cassirer, given his emphasis on the role of causation and teleology as world-building functions, demonstrated by Kant in the *Critique of Judgment*, saw the overall project of Kant's critical work as an attempt to affect just this kind of reconciliation between forms of experience.[12]

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[10] For more on the transition from the schema to the symbol, as well as the central role of the symbol for Cassirer, see Charles Hendel's introduction to the English translation of PSF I, and also (Verene 1966, 555–556; 1969, 36; 2011, 4–6).

[11] For more on moving from the critique of reason to the critique of culture, see (Randall 1949, 694; Skidelsky 2008, 100; Orth 2011, 123).

[12] For more on the emphasis on and significance of the *Critique of Judgment*, see (Chevalley 1996, 230–3; Verene 2001, 14; Schmitz-Rigal 2009, 77–79). And for an

This observation allows us to once again see the full historical significance of Cassirer's own project of symbolic forms: using the world-building function of the symbol to subsume the theories of both knowledge and aesthetics is the key to their reconciliation (Chevalley 1996, 232–233; Friedman 2003, 22). This subsumption comes through the universality of the symbol, making the symbolic forms project a continuation of Kant's critical work. But he does not merely want these independent forms of experience to awkwardly stand side by side with no means for contact, which is why he situates them with respect to one another through a Hegelian dialectic, through his phenomenology of the forms.

Before exploring Cassirer's account of the three main symbolic forms, I would first like to define a few terms that are central to his work. The first is the symbol, which as we have seen is the unit in which sensuous and meaningful inhere. That inherence itself, the way that a symbol is immediately imbued with meaning, is termed "symbolic pregnance" (PSF III, 202; see also PSF I, 102). The symbol itself is already pregnant with meaning. Neither the sensuous nor the meaningful aspect of a symbol is primary; we always encounter the one in the other and the other in the one. In fact, even their separation is only a later move, a subsequent logical analysis through which we idealize and isolate these two factors, which in fact never exist apart from each other.[13]

It is important here not to confuse symbols and signs (PSF III, 323–326). Signs only indicate something of fundamentally the same order. For example, a wall plate indicates the way to the library. The wall plate is a physical object; so is the library. By contrast, the number 4 is not of the same logical order as the function that generates the entire series of whole numbers, as we saw in the previous chapter. To adopt the language Cassirer uses to discuss mathematics, we must not confuse series members and series forms. The number 4 is a member of the series, but the function generating that series is the series form; it is not itself a member of that series. This language also helps us to clarify the difference between signs and symbols.

The relationship between a sign and its intended object is a relationship of two elements on the same plane, akin to one series member indicating another series member. By contrast, a symbol indicates its meaning as something on another logical plane, like a series member indicates its form.

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excellent discussion of the possibility of applying transcendental analysis to the world of myth, a problem that seems to trouble many commentators, see (Ikonen 2011). Ikonen's basic thesis is that Kant's *Critique of Pure Reason* addresses the "scandal of knowledge," which is that skeptical doubts cannot be refuted but sheer dogmatism seems unacceptable. In parallel fashion, he interprets Cassirer's critique of culture as an analogous response to the "scandal of other minds."

[13] On the topic of sensuous and meaningful being initially interwoven and subsequently distinguished by analysis, see (PSF I, 107–114; PSF III, 27; PSF III, 114–115; PSF IV, 21; Krois 1987, 22; Naumann 1999, 577; Verene 2011, 54).

Members of a series can exist without one another; a series member cannot exist without its form, just as the form has no meaning but to delineate its members. A sign could exist in the absence of that which it is supposed to signify; but a symbol could not exist without its symbolic form.

But what is a symbolic form? In the previous chapter, we saw that numbers take their meaning from the place they occupy in a series, a series defined by a particular rule. The same is true of all symbols.[14] Each symbol is a junction between the sensuous and the meaningful, but on the side of meaning, the symbol is not entirely self-contained. Rather, its meaning draws on a totality of meaning, on a structure. Each such structure is known as a "symbolic form," and each allows a single part to echo a totality of meaning.[15]

We can now speak a bit more concretely and explicitly about the relationship between symbols, symbolic pregnance, and symbolic forms. What we encounter in experience is always a symbol, something both meaningful and sensuous at once. Symbolic pregnance is the manner in which that meaning inheres in the sensuous. And the symbolic form is the totality of meaning to which the individual symbol belongs. Thus, whenever we encounter anything in sensuous experience, it is meaningful from the first, implying a totality of meaning through the symbolic form of which it partakes. The sensuous and meaningful are two moments separable by analysis, but have no meaning in the absence of the other. These two moments must therefore not be collapsed, despite the fact that neither has any meaning but for the other. Meaningful and sensuous are only for one another, but they are not identical to one another, nor collapsible one into the other. The same is true of the symbol and the symbolic form of which it partakes, neither having any being except for the other. They are functionally intertwined. The same relationship is found between a given number and the series to which it belongs, because that number is a symbol and that series is (part of) a symbolic form.

A rule generates a series of numbers. Each number takes its meaning from that rule, and therefore echoes all the other numbers in that series. Similarly, the sensuously present is always pregnant with a totality of meaning, and thereby echoes the sensuously absent. This language may seem convoluted, but it means something quite straightforward, as we can see with a simple example. When I look at the cover of a book, only its front side is sensuously present to me; but it is a physical object in space, and I therefore know that it must have a back side as well. This knowledge is immediate, not inferred. Only the front is sensuously given, but in a sense the back is present to me as well, because the object must end somewhere. I see only the front, but I experience the book as a whole, including its back. The front and the back of the object are both sensuous, they both exist at the same logical level. Spatiality as such, however, is no object "beside" or "between" or "above" the book. Rather, spatiality has an ideal existence. The front and the back of the book are tied together through this symbolic structure. Consequently, when the front of

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[14] Though only in mathematics and science are those rules totally explicit. See §4.4 below.

[15] For more on the definition of a symbolic form, see (PSF I, 108; Krois 1987, 50; Verene 2011, 8–13;

the book is given to me in experience, its back is also given, through the medium of the symbolic form. Symbolic pregnance thus means that the present is always given along with the not-present (PSF III, 114; Leroux 2010, 39).

I'm describing this structure not to conclude anything terribly revolutionary, but rather to map Cassirer's theoretical edifice onto some notions that are hopefully already familiar. The way that the absent is given in the present is quite similar, if not identical, to the theory-ladenness of perception. Experience is always modal from the start; we don't live in a world of actuality alone, because each thing that we experience already presents itself as a nexus of possibilities and necessities.[16] The front of the book already necessitates that it has a back, without any intermediate steps of reasoning. That's because the sensuous is never given without being situated in a context of meaning; perception is theory-laden from the very first.[17] Symbolic forms, like theories, are therefore much more prospective than abstractive (PSF III, 305–309; Cassirer 1949, 871).

§4.3 Parameters of symbolic forms: function and category

Symbolic forms, as totalities, define the individual symbols that figure in them. Through that totality, each sensuous part resonates the whole, "one blow strikes a thousand chords" (PSF I, 108). That's the role of the symbolic form, but they don't all accomplish that function in the same way. Actually, the language of functions can be helpful here: the symbolic form, as a general formula, is a function containing several variables. Which values are plugged into those variables differentiates the symbolic forms from one another; but they all fundamentally draw on the same function, the same general structure, in virtue of which they can all fulfill the same role. In this section, we'll outline what those variables are and the possible values for them. In the next section, we'll actually explore the forms that we build thereby, and their phenomenological development from one another. (Thus, this section is more akin to Kantian, transcendental analysis, examining the conditions of possibility for symbolic formation. The next section is a Hegelian, dialectical analysis of their emergence.)

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[16] For some interesting parallels, ones not arising in the context of Cassirer scholarship, see (Putnam 1962; Trestman 2013). See also Nelson Goodman's famous claim: "All possible worlds lie in the actual one" (1954, 57).

[17] In a particular passage in *Substance and Function* (1910, 284), Cassirer explains his use of the word "representation." I think that this passage is crucial for understanding his project, specifically because "representation" is a word that is so easily brought into the context of correspondence notions of truth, which Cassirer entirely rejects. By "representation," Cassirer doesn't mean that something in sensuous perception refers to a substantial world behind perception, a *Jenseitswelt*; rather, "representation" indicates the way that a sensuous particular can point, through its inherent connection with meaning, to the totality of the sensuous world. That's the true sense in which science aims at accurate representation: it aims to sew together the world of sensuous experience into a coherent whole, using meaning as the binding thread. For more, see (PSF I, 97–98; Leroux 2010, 41).

Symbolic forms are delineated along two axes: categories and functions. Each symbolic form must give a tonality to the categories of space, time, number, cause, object, and experiencing subject (i.e.: the self). Each form thus has a characteristic tonality to it, and this tonality is determined by the admixture of the symbolic functions: expression, or *Ausdrücksfunktion*; representation, or *Darstellungsfunktion*; and signification, or *Bedeutungsfunktion*.[18] These functions are ways in which meaning inheres in the sensuous; that is to say, they are different facets of symbolic pregnance (PSF III, 101).[19]

The expressive function is characterized by immediate inherence; there is no gap between the sensuous and the meaningful, they seem totally identified. The representative function is characterized by absolute alterity; the gap between sensuous and meaningful seems ultimate, and they appear never to touch. The significative function is characterized by sustained dialectical tension; the sensuous and the meaningful do not collapse into one another as they do in the expressive function, nor are they completely alien to one another as in the case of representation. Instead, meaningful and sensuous remain necessarily interrelated, having no meaning except for one another, and yet neither is able to conquer the other. They stand in sustained, unresolved tension.

Remember, these functions are not symbolic forms. Symbolic forms are constructed using these functions as building blocks, as timbres to set a characteristic tonality for each of the categories.[20] Each of the categories can be filled in through any one of these functions. Take representative time, for example, where all times are separated from all others, radically different from and incommensurable with each other. Temporality built according to such a model gives rise to Zeno's paradox: as an arrow flies through the air, it is at rest at each instant, and never in motion. How could motion possibly exist if it were simply a summing up of instants in which everything is at rest? Motion could not be "between" these instants, because all that stands between them is just a collection of more instants, and the arrow will be at rest in each of them as well. These instants are totally alienated from one another, each self-standing and lacking any relation to the others (PSF I, 222).

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[18] These three functions, the tonalities, are often named interchangeably with their archetypal exemplifications. E.g., the expressive is often used interchangeably with the mythic. I think that this murkiness has led to some misunderstandings of Cassirer's work, for example, Carl Hamburg's criticism that I will address in §4.7. Accordingly, I will take great care to distinguish between a symbolic function and a symbolic form, in the hope of avoiding such errors. But when reading primary and secondary literature on this issue, please keep the distinction in mind as I believe it will be helpful in understanding Cassirer's project. And know that other authors, often including Cassirer himself, are not always overly careful with their language in this respect.

[19] For more information on the functions, see (Cassirer 1927, 417–418; Hamburg 1949, 96–101; Stephens 1949, 164; Verene 1969, 38). On their application to the categories, see (PSF I, 94–95; Cassirer 1927; 419; Stephens 1949, 166; Hartman 1949, 300–301; Verene 1966, 557–558; 2011, 41–2; 2011, 57).

[20] (PSF I, 97; PSF III, 14–15; Verene 1969, 44–5; Cassirer 1979, 417–419; Capélleires 2007, 343–344; Orth 2011, 130).

The way out of this paradox is to recognize that these instants are temporal substance, and the way to connect them together is not with further substance (i.e.: more instants). Rather, we need a connection that stands on a different plane; we need an ideal connection, a thread of meaning to sew together the sensuous substance. Meaning and substance do not collapse into one another, as the ideal connection between instants is not itself just a further instant. But at the same time both substance and meaning have no application except to one another. This move shifts us away from representative time and into significative time.

This paradox and its resolution were meant only to demonstrate how the symbolic functions can fill the categories in different ways. Each of the three functions can fill each of the six categories, so it would take 18 examples to elucidate each one. I will not run through each one now, though we'll see more examples, and in more detail, in the next section.

Before moving on, though, I'd like to briefly outline how each of these three functions has a role to play in clarifying the notion of symbolic pregnance. The expressive is the model for the immediate connection between sensuous and meaningful, the way that symbols are given in experience already containing both facets in immediate fusion. The representative models show how, despite that inherence, meaningful and sensuous aspects do not collapse into one another. These two facets remain two; the sensuous-pole and the meaning-pole remain antithetical to each other, they push against each other. It is only through the significative function that this internal tension, the immediate inherence coupled with absolute alterity, can be preserved without being resolved. The preservation of tension is not a victory of either over the other. Rather, it is a recognition of the tension itself as fundamental and productive. Meaningful and sensuous content only are for the sake of each other: this is the characteristic two-in-one structure of the symbol (Hamburg 1949, 95). As in the case of numbers and generating series, the tension between the two is preserved rather than effaced; it's a preservation of difference between the two logical levels.[21]

§4.4 Phenomenology of culture

Now that we've laid out the symbolic functions, and the categories that need filling, we can finally start to explore myth, language, and science. These three are the archetypal examples of expression, representation, and signification, respectively. However, it's important to note that all three functions are actually in each of the symbolic forms (PSF

[21] Verene uses some helpful language here, referring to expression, representation and signification as unity, disjunction, and reunification, respectively. Reunification would not be possible without prior unity and separation (1969, 40). For more information on mapping the functions onto facets of symbolic pregnance, especially using mathematical functions as the model for this process, see (PSF I, 104; PSF II, 64–5; Hamburg 1949, 100; Stephens 1949, 153–154; Krois 1987, 25; 1987, 54; Verene 2007, 98; 2011, 55). For a depiction of the whole relationship between symbolic forms, functions and categories as a mathematical function, see (Capélleires 2007, 324).

I, 46–49; PSF IV, 216; Hamburg 1949, 114). Additionally, the list of symbolic forms is not limited to these three, as Cassirer himself makes clear, for example, in his *Essay on Man* (where he mentions history, art, and law as additional forms). What's important to keep in mind here is that these three forms are exemplary, not exhaustive; anything that uses the three symbolic functions to fill the parameters of the categories thereby builds a world of meaning, and symbolic forms are nothing but such totalities of meaning.

§4.4.1 Myth

Let's begin in the mythic world. This form of life begins in rites, not in the narratives that we use to explain those rites, even though it is those narratives that we commonly refer to these days when using the word "myths" (PSF II, 39; PSF IV, 75; Krois 1987, 16). The overriding tonality of the mythic world is defined by the principle of "*pars pro toto*," or "the part for the whole." This principle defines the central axis around which the mythic world revolves, and what it means is that the part is always allowed to stand in for the whole.[22] This relationship of immediate inherence of part in whole is what makes mythic thought so helpful as an exemplification of the expressive function.

What does this immediate inherence entail, in practice? In the mythic world, nothing represents anything else; it becomes that thing. For example, the dancer who puts on the god-mask does not *play* the god, she is not *acting*. The dancer *becomes* the god (PSF II, 39). A man's life and power are totally contained within his shadow, which explains why he can be murdered by stabbing his shadow (PSF II, 42). There is no gap between any of the parts that belong to a single essence: the mask is just another physical manifestation of the god's essence; the shadow is just another physical manifestation of the man's essence. An essence is simple, undivided, and wholly present in each of its instantiations. Because of the unity and simplicity of essence underlying the manifestations, the mythic world is one of constant metamorphosis as essences take on now one physical form, and then another (PSF II, 142; PSF IV, 67).

But we're getting ahead of ourselves here. The mythic world is immediate, and the mythic self is totally tied up in it, living in a sphere defined entirely through emotional expression. We have as yet no separation of subject from object, no dispassionate mind gazing out onto an impartial world. The mythic world begins in a realm of pure emotion, of fear, panic, joy, and ecstasy. When these outbursts start to coalesce, when they begin taking shape, they start to be objectivized and set in a world held at a distance from the subject. The self starts to look onto the world for the first time. We thus see the emergence of gods and demons, which are the first substantiations of experience, the first objects of contemplation (Cassirer 1925, 32–38). Gradually, these momentary flashes begin to take on a recurring character; we move from momentary flashes of othered emotion, to the recurrence of a single emotion. But because this emotion is set in the

[22] Notice that mythic thought does not actually divide parts from wholes in the way we are now doing in order to describe it. That's in fact exactly what this principle means, though our attempt to express it in language requires us to make a division alien to the mythic world itself. For more on *pars pro toto*, see (PSF II, 52–3; PSF IV, 67; Cassirer 1925, 57; 1925, 89–92; Krois 1987, 93).

world as an object, it has become an expression of a demonic or holy power. As these gods and demons develop, they take on names, images, personalities, and so on. All of these facets hang together as expression of a unified underlying essence.

We've now seen the first major division in experience: the division between the sacred and the profane, the holy and the unholy, the divine and the evil. Manna and taboo are the sacred and the profane, respectively, in their general form,[23] and they are the common filaments threaded through each part. Through the underpinning of manna and taboo, all parts partake entirely of their wholes. Through the common link of manna, all of the holy partake of one common essence; the partaking we characterized earlier as the principle of *pars pro toto*.

Manna and taboo, and *pars pro toto*, give us the tools we need in order to understand the tonality of the mythic categories. Mythic space is no impartial space. As divisions begin to form between east, west, north and south, each cardinal point is from the first imbued with a particular power, and with the god associated with that power, as the god and the spatial point partake of a common essence. We are not here speaking of an independently developed god and an independently developed spatial schema, where elements from each realm are subsequently glued together. As the essence of death, say, grows more and more clarified, the god of death and cardinal point of the north come to be clearer also. The clarifying essence of death *just is* the clarifying of the god of death, the clarifying of north. All spatial delineations arise in the same manner for mythic thought, including the emergence of the zodiac and even the differentiation of different parts of the subject's body (PSF II, 92–98).

The same structure governs mythic temporality, in which the parts of the day and the seasons of the year develop each with their own characteristic feeling. Darkness, winter, and nighttime are emblems of death; light, summer and daytime are emblems of life. The spring and the sunrise are rejuvenating; the autumn and the sunset are decline. And these temporal regions are completely intertwined with spatial regions as well: death appears in the guise of the north just as it appears in the guise of the night, in the guise of the winter; these are nothing more than the metamorphosing garb of death, who is the shape-shifter appearing now as this, now as that. Thus, space and time are only gradually distinguished

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[23] For more on manna and taboo, see (PSF II, 76–78; Cassirer 1925, 62–72; Krois 1987, 96). Cassirer breaks down the growing differentiation within the mythic world into five stages. Mana and taboo are the first coagulations of good and evil. This is the first stage of differentiation. The second, third, and fourth stages are momentary, functional and personal gods, appropriated from the taxonomy developed by Usener (Cassirer 1925, 17–21). The fifth and final stage of mythic thought, which is once again Cassirer's addition, is monotheistic religion, within which all the powers of all the gods are gathered into a single overarching god (PSF IV, 70–72; Cassirer 1925, 72–74; Krois 1987, 97). Cassirer argues that Christianity's prominence is at least partially due to its successful refashioning of pagan mythology, the integration of these myths into Christian theology (PSF II, 102).

from each other, as the spatial and temporal divisions are but expressions of a common underlying essence (PSF II, 107).

Mythic numbers are also tied up in this same structure, taking their meaning from the cardinal points, seasons and gods with which they are associated. Mythic numbers are the furthest things from our scientific notion of a mere placeholder, just a position in a dispassionate order delineated by an explicit rule (PSF II, 142–149).

The mythic world is often criticized for having no causality, or perhaps for refusing to acknowledge evidence that its rituals are not causally effective. But cause in the mythic world simply means something completely different from its scientific counterpart; mythic causation is completely dominated by the *pars pro toto* principle, and is sensitive to spatiotemporal and numerical features only insofar as those features express their underlying essence, but not one step further. As we saw earlier, to stab a man's shadow is to kill the man; to wear the god-mask is to become the god; a man can avoid death by wiping a healing salve on the arrowhead that wounded him, even if the wound is already inflicted; etc.

These practices are not causal by our scientific lights; they are not established as spatiotemporal regularities that sew together a world of geometrically measured objects. Causes and effects can be drastically separated by space and time or they can be very proximate, and in both cases mythic causation draws on expressions of common essence. In fact, because expressions of essence define the mythic world, it is even more rigidly causal than the scientific world: the mythic world allows no accidents, because everything is essential expression. Nothing is allowed to happen at random, so everything gets an explanation, without exception.[24]

But there are those who would say, "But the man still died, even though you wiped the arrowhead with oil and flowers! Don't you see? It doesn't work!" Surely this is the way that scientific eyes look on the mythic world. But did the man die? What is our evidence that he died? Surely, the corpse itself is evidence; what more proof could we want? But this is not evidence in the mythic world: the man and his body (which are not yet separated in mythic consciousness) partake of an underlying essence. The *essence* is the real object in the mythic world, and while the essence only ever crops up in the world in one garb or another, it is never totally limited to that garb. Thus, the corpse is not evidence of death. The shape-shifting essence still lives on in its other manifestations.

Here, we see how all the categories are tied together through their symbolic function; space, time, number, causation, object, and subject are all inter-related and inter-defining. As we've seen in each instance in myth, as the symbolic function of expression grows up and develops in the symbolic form of myth, all of the categories develop in a harmonious whole. A fully determinate sense of object never precedes a sense of causation, or of

[24] For Cassirer's full treatment of mythic causation, see (PSF II, 43–49; Krois 1987, 94; Verene 2011, 39–40).

space, or any of the other categories. This is as true of myth as it is of science, as we have seen in these foregoing examples and in §3.6 of the previous chapter.[25]

It is important to recognize here that the criteria of objectivity are thus internal to the symbolic forms. Each form, science included, builds its world according to its own inner character, and only by that yardstick may it be measured. To criticize the mythic world for failing to be scientific is a misunderstanding of the role that symbolic forms play in constituting the world. If such demands were acceptable, then the scientific world would surely show itself to be a confused and misguided contortion of myth, just as myth shows itself to be thoroughly unscientific.

In the realm of myth, the experiencing subject is the final category for us to explore. Having seen some evidence of how intertwined the categories are, going back to explore mythic time a little more will help elucidate the topic of temporality. Specifically, I want to examine the relationship between past and present in myth. The mythic past is the absolute beginning point, the creation stories, the taproot of the godly and demonic powers. There is a rigid distinction between this taproot on the one hand and real, lived time on the other; but within lived time, there is no distinction between past, present and future. Here is the gap between mythic history and the cultural histories of the modern, Western, European-descendant world: whereas mythic history posits a strong duality between lived time and its historical taproot, Western history posits one continuous linearity. Therefore, in the mythic world, a historical explanation need only tie back to the taproot, the creation story of a given essence; any such explanation is always necessary and sufficient. By contrast, explanation in Western history can always inquire further, can always go one step further back, *ad infinitum* (PSF II, 104–6).

This mythic taproot is very important, because our whole community comes from it, not just ourselves as individuals. The whole community is tied together through its common genesis, which is why individual action brings about communal punishment. When the hunting party goes out, those at home will not wash their hands for fear that making the communal hands slippery will allow the hunted prey to slip through them. There are not hands at home and hands on the hunt; there are only the community's hands. And as we've seen, the world is a place of demonic and godly essences, similar in kind to the essences of which we ourselves are expressions. Therefore, subjectivity in the mythic world is not originally an "I" standing across from an "it," but a "we" standing across from a "you." The whole world is personified and communal; individuality and disinterested objects only emerge gradually through the development of religion, art, and language (PSF II, 175–199).

The study of myth is one of the most original and insightful features of Cassirer's work. Its originality stems from the fact that Cassirer is not trying to explain myth as a

[25] Cassirer's whole project in *Determinism and Indeterminism in Modern Physics* is to show this interdependence to be at work in quantum mechanics. His remarks about this interdependence in the mythic world are found in (PSF II, 50). For another treatment of space, time and number in myth, see (Verene 2011, 42–44).

psychological illusion, not trying to explain it away. Neither, though, is he trying to give arguments for the necessary existence of God. His intention is neither to reify mythico-religious thought, nor to dismiss it. Rather, Cassirer's intention throughout the symbolic forms project is to reconcile different worlds of experience, to bring the symbolic forms into consonant harmony without leveling off the differences between them, without bringing them into unison.

His account of myth, therefore, is not a historical, sociological, or psychological reduction of myth, nor is it the dogmatic assertion that God exists. What Cassirer explores in his theory of the mythical world is what it means for God to exist, as existence itself is a feature that we find *within* symbolic forms. This approach is completely different from dismissing myth as illusion, an illusion of which we try to rid ourselves through logical reasoning (PSF II, xiii–xiv; PSF II, 11–12). Thought cannot banish what it cannot understand; and if we wish to fully embrace the symbolic form of science, we must enter into the mythic world on its own terms and see how science grows out of the mythic world (PSF II, xvii).

§4.4.2 Language

The mythic world is one of powers and essences, of emotions and will, where these powers are solidified into objects, thus first creating a gap between the subject and the world. How does this gap first open up, the gap between the subject and the world? Three hairline fractures start this process, as mentioned above: religion, art, and language. I will briefly discuss the first two, as they also play important roles in Cassirer's thought, but it is ultimately language on which I will focus in this section, as it is the exemplary case of the representative function.

In religion the fissure begins with a separation of the will of God from the world. In mythic thought, the real is an expression of the sacred and the profane, but in monotheistic religion, we see a characteristic gap opening up between the will of God and the reality on earth. This is the original separation between the ideal and the real, which forms the basis of ethical duty. God's will is defined as perfection itself, the ideal end that ought to be realised. We, as the agents of that will on earth, have a duty to make the real approximate that ideal as closely as possible. Here, we see the end of the mythical: the ideal world is the expression of God's will, but the real world itself is not. The real world is beholden to the ethical demands of God, but a causal mediator, an affecting mechanism, is required to enact that will. Thus, the real is not immediately the sacred anymore. The sacred has become an object of explicit reflection, something we can hold out before ourselves and examine as such. A space has finally opened between the symbol and the symbolized, a space that never existed in the mythic world.[26]

We see a distancing function at work in art, also. As the mythic world traverses the development from momentary flashes of godly/demonic presence, to their recurrence, to

[26] For more on religion's transition from expression to representation, see (PSF II, 239–241; PSF III, 328–329; Cassirer 1925, 72–74; 1933, 28; 1979, 176; Skidelsky 2008, 104–111).

their personification, the development of images helps to stabilize their inherence. A recurring image acts as a centre, a physical token in which the essence inheres, and that makes it easier for consciousness to recognize and reflect upon the recurrence of that single essence. At first, of course, the image is just another fragment of the essence, and therefore has the full potency of the essence within it, which is what explains murder-by-stabbing-of-shadow. It also explains injunctions against iconography: to possess the image of a deity is to possess that deity's power, which subordinates the deity to the possessor, the greatest blasphemy.

But the image, because it has a persisting physical manifestation, can be contemplated for its own sake; it can act as a medium through which mythic consciousness can come to be aware of imagery in general, where the image *represents* that which is depicted. The transition to the representative function is fully visible when the focus shifts from the image as expression of essence to the image as standing in for that essence. Here we stand at the threshold between the expressive and the representative functions.[27]

Just like the image, the word starts off as just one more fragment of an essence, with all of its potential powers. We examined the injunction against iconography above, and in parallel fashion we find gods unwilling to surrender their names, by which act they would surrender their power to possession by another. For example, we find in Egyptian mythology that Ra would reveal his name to Isis only on his deathbed, when she claimed that uttering his secret and personal name was the sole means by which he could be healed. (Isis, of course, had secretly poisoned Ra, and cured him after learning his secret name, thereby gaining power over him through her trickery.)

We see exactly the same steps in language as we did in art as they both emancipate themselves from the foundation of myth; the name of the god helps to stabilize otherwise fleeting impressions. The fluidity of experience is constantly in danger of slipping through our fingers until we dig canals in which it can run. Thus, the name plays a role in channeling the flow of experience, shaping the thing that it names and thereby consolidating it.[28] As the named objects grow more and more solidified, they more clearly stand across from us as objects of experience, of contemplation. Thus, the gap grows between experiencing subject and experienced object. Self and object are not two original unities that we must subsequently bridge. They are rather two strands only progressively disentangled, emerging as two poles of a relation, developing in lockstep.[29]

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[27] For more information on the role of art in the development from expressive to representative functions, see (PSF II, 25–26; PSF III, 90–91; PSF III, 112; PSF IV, 78–84; Cassirer 1925, 97–99; 1927, 424–427; 1979, 154–165; 1979, 185–186)

[28] For further elucidation of the role of language emerging from the mythic world, see (PSF II, 239–244; PSF IV, 70–72; Cassirer 1925, 20–21; 1979, 172–177; Krois 1987, 97).

[29] For more on language solidifying objects, see (PSF III, 77–79; PSF III, 107–111; Cassirer 1933, 26–32).

Two prominent questions that we ask about language are here shown to be falsely formulated, disclosing a faulty initial assumption. The first question is whether expressive or propositional language came first, whether outbursts and cries were the original bedrock of language, or rather whether it started out as propositional language, referring to dispassionate states of affairs. The answer to this riddle again lies in realizing that in fact the two emerged from their original amalgamation, that they were only slowly and laboriously disentangled. In the mythic world, there are no dispassionate facts in an outer world, but neither is there a finished "subjective interior" from which expressive outbursts might emanate. The separation of inner and outer, emotional and propositional, is only the latest product of language and experience, not its starting point.[30]

The second question is whether nouns or verbs arose first in language, that is, whether objects or actions are primordial. Because language emerged from the realm of myth where all action is the manifestation of a substantial essence, and essence is never apprehended except through its manifesting, language itself begins with noun-verbs. Acting object and action itself are only progressively disentangled. It is only after this disentangling has been accomplished that we can look back and ask which came first, but the real answer is that the two at first came as one (PSF I, 219; Cassirer 1925, 12; 1979, 178–9).

Once we start from a world of dead matter and expressive outbursts, where these two features are totally independent and alienated from each other, the gulf can never be bridged, and skepticism is inevitable.[31] This type of move is typical for Cassirer: whenever he sees two poles that seem totally irreconcilable, he always asks whether they started out that way or whether their separation is the product of gradual analysis and disentanglement. He uses the copula "is" to demonstrate the latency of their original involvement. That the copula can express something simply existing, or can identify one thing with another, shows the inherently expressive and propositional nature of language. The former is immediate, the latency of mythic thought, whereas the latter is relational, the first preparatory stage for scientific thought (PSF I, 316–317; Cassirer 1925, 74–76; 1942; 313).

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[30] Regarding the disentangling of subjects and objects, their emergence in lockstep, see (PSF I, 90–101; PSF I, 178–184; PSF II, 23–34; PSF III, 77–91; PSF III, 123–124; PSF IV, 93; Cassirer 1933, 30–3; 1942, 326; 1979, 149; Krois 1987, 56; 1987, 88; 1987, 108; Bayer 2001, 96; Skidelsky 2008, 117; Leroux 2010, 44–45; Verene 2011, 24–25; Ikonen 2011, 190). On demonstrations of this disentanglement from case studies in child psychology, see (PSF III, 64–73). Because language disentangles object and subject, it also has an important role to play in ethics, a role in constituting the ethical subject (Cassirer 1933, 28). The will also plays an important role in separating the desiring inside from the desired outside (PSF II, 40–41). Lastly, see Cassirer's writing on technology for the mediating role that it plays, and especially its connection to the scientific world of causality.

[31] On myth and dead matter, and the resulting skepticism, see (PSF II, xvi; PSF II, 24–25; PSF III, 101–103; Cassirer 1933, 37–39; Krois 1987, 57–60; Leroux 2010, 15; Orth 2011, 127; Ikonen 2011, 191).

Let us now turn our attention to the categories and see how they operate and develop within the world of language. The original spatial division within language is simply the here divided from the not-here. Taking his cue from research in the history of linguistics, Cassirer argues that objects are always initially situated by language within an I-space or an I-and-you-space; that is to say, objects at first appear in relation to the individual speaker or the community of speakers (PSF I, 201–203). Demonstrative pronouns are the first to reign in this kingdom, and always operate within the perceptual boundaries of the speaker. Furthermore, the pronouns initially arise in the context of practical applications. Only gradually does the context-neutral, "pure," pronoun arise, as the practical relation tying the object back to the self/community gradually fades into the background. It is also at this time that definite articles emerge, again initially dependent on the plurality of practical contexts and gradually "purified" (PSF I, 204–207).

A remarkable change occurs with the appearance of prepositions: consciousness can now navigate a world where objects not only relate back to the self, but also interrelate with one another. The result is a linguistic world constituted not only of "that" and "the" but a coordinated network of "beside the." With this development, we have words for structural relations. As we saw in the case of myth, once the word arises we can make its referent an explicit object of consciousness; in the mythic context, the emergence of the word helped to solidify the god, and here in the linguistic context, the preposition helps to solidify structural relations between objects. It is this prepositional network of relations that first allows us to examine relational structure directly (PSF I, 208–213). The cognizing subject also takes on a new look with this development, as it begins to be defined as a centre of action, a location in the network out from which the will radiates (PSF I, 213–215).

Because language only gradually sculpts itself out from the stone of mythic thought, and because mythic space and time interpenetrate one another through their connections to the sacred and the profane, it should come as no surprise that linguistic time originally starts out rooted in determinations analogous to those we find for linguistic space. The first linguistic division we find for time is the now and the not-now (PSF I, 216–8). As we saw above, action is initially tied up with both nouns and verbs. Temporal features are therefore initially part of the substance of actions and objects, rather than just providing a relational structure in which those actions and objects are situated. The substantiality of time starts in the now/not-now distinction, which subsequently develops into a distinction between completed and uncompleted actions, and a distinction between momentary and enduring actions. Pure relational order is the final step of temporal development in language (PSF I, 218–220; see also the discussion of Zeno's paradox in §4.3 above). Once again, prepositions play a key role in creating a relational structure in which objects and actions can appear relative to one another, rather than always strictly in relation to the speaker. [32]

[32] In PSF III, Cassirer again elaborates the phenomenology of the linguistic space (148–161) and time (163–189). See those passages for a second run at the target.

The emergence of relational numbers in language requires building blocks established first in linguistic space and linguistic time. At first, the numbers start out rigidly tied to body parts that we use for counting. The child learning to count on her fingers is no cultural accident: the numbers are tied to the physical fingers, because the rule for counting is simply an order of progression, numbering off the body parts in the stipulated order (PSF I, 226–235). The concepts of unity and plurality gradually emerge, where we start to see pluralities as individual unities bundled together. This is in fact quite an accomplishment; plurality requires holding unities separately and together: separately because each is one, and together because it is to the group of those ones that we are referring.[33] The holding together is drawn from spatial intuition; the holding apart of the individual pieces, and according to a directional order, we draw from temporal intuition (PSF I, 235–239).

Numbers begin rigidly tied to practical contexts, emerging from the mythic world. Rudimentary languages often stop at 3, with 1 being tied to the I, 2 tied to the you, and 3 tied to the (s)he. Only gradually are these sensuous and expressive garbs cast off. The liberation of numbers from practical contexts, and from the physical objects to which the order of progression initially applies, is a further intellectual accomplishment. Thereby numbers finally emerge as the pure relational structure, undergirding science (PSF I, 242–248) as we saw in §3.

With this development of space, time, and number, we can see the characteristic trend of language: it always grows from expressive, practical involvement towards pure relationality. It always spans that gap without ever fully touching either one. It grows out of the purely expressive, but is itself always relational; and it grows asymptotically towards the purely relational, but never arrives there because language always retains a tinge of the expressive. Though prepositional language situates objects in a relational nexus, that structure always emanates outward from the subject; it always remains fundamentally centrifugal.[34]

Furthermore, the mode and content of expression are never totally separated. We certainly begin to disentangle the two and analyse them separately, but their inherent bond is never broken in language, despite our ability to focus more specifically now on one pole of that relation and now on the other. Language remains fundamentally

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[33] We see linguistic evidence of this in group nouns, which ought to be singular, but their verbs are conjugated in the plural: e.g., “A lot of people are going to the fair,” as opposed to, “A lot of people is going to the fair.” Even my word processor doesn’t know what to do with this. It has surely been carefully instructed to accept either formulation because the English language still hasn’t sorted out just whether we’re talking about the people or the lot.

[34] That is not to say that there is a transcendental subject that precedes the structure of spatial experience, linguistic or otherwise. Rather, the claim being made is only that linguistic space is always oriented from the subject outwards, that each location in linguistic space refers back to the subject, which is at the spatial centre.

metaphorical; but in spite of this fact, language still plays an undeniably important solidifying role for consciousness (Cassirer 1925, 84).

The representational function is best exemplified by language because of its ability to solidify experience into a substantial world, one that stands across from the subject, that the subject can contemplate explicitly (PSF II, 25–26; Krois 1987, 99). Language solidifies the world of experience into one of facts: objects, events and actions are slotted into relational structures and thereby allowed to stand before us, seemingly of their own accord. As language develops, the world stands more solidly on its own two feet, and thereby appears totally other to us: the linguistic world is a totality of facts, it is everything that is the case. As the alterity of the world develops, we see a corresponding change in the experiencing subject, which grows into a pure receptacle for experience. The relationship between subject and world is entirely definitive of the relata,[35] with the world becoming pure content and consciousness becoming pure form.

Inevitably, language soon reaches a crisis: we soon encounter a foreign language, one in which we find a completely different relational structure and therefore a different parsing of the world. This crisis comes about because of the two features of language mentioned above: its centrifugal nature, and its metaphorical character, which is the ultimately unbreakable bond between mode and content of expression. But this crisis is serious, as an ostensible totality of facts cannot tolerate a competitor. If the world is completely objective and other, then disagreement between languages shows that one must be wrong. How can we determine which one? Here opens the space for skepticism.

This skepticism makes the relationship between language and the world salient; it brings it into view, so that we can look on linguistic symbols directly rather than always seeing through them. Recognizing the loose connection between words and the facts they attempt to denote, we see an arbitrariness in symbolization. This arbitrariness later comes to be exploited as an important axis of freedom in the purposeful creation of symbolic systems, in science. The crisis of facts thereby first clears the path towards the scientific form, but must always pass through the explicit reflection on linguistic symbols as such (PSF III, 323–332).[36]

§4.4.3 Science

The transcendental analyses of science, the conditions of its possibility, were already discussed in detail in §3, and I shall not rehearse that material again here. However, what

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[35] The relation defining the relata should not here suggest that we are falling into the open arms of structural realism all over again. Recall that these relations occupy a transcendental and not a transcendent position. See §3.7 for a clear statement of the arguments that necessarily drive a wedge between Cassirer and the structural realists.

[36] Cassirer's solution to this crisis is to recognize that language plays an active role in shaping the world, rather than just being a copying mechanism for the given. The world simply isn't given to us as finished, as his discussions of linguistics, child psychology, and neuropathology seek to demonstrate. For more on the crisis of languages, see (PSF III, 205–279; Cassirer 1933, 20–3; 1979, 182; Krois 1987, 101; Verene 2011, 29).

we are now able to add are some remarks about its phenomenological emergence, gleaned from the dialectical analysis we've been exploring so far in §4.4. For instance, some may well have wondered, especially in §3.5 and §3.8, whether claiming that physics must "save the phenomena" is already re-introducing a dualism between theory and world into Cassirer's edifice. At this point in our analysis, we can now properly understand that remark: science must begin with the phenomena (and the questions) that it draws from language, and gradually emancipate itself from the linguistic world, just as language gradually emerged from myth. Scientific theorization does not meet an unsymbolized world, which it then must organize; scientific theory takes its lead from a linguistically formed world, from the crisis of facts.[37] Some examples of this progress of development from the mythic/linguistic world are the emergence of astronomy from astrology, chemistry from alchemy, and algebra from almacabala (PSF II, 144).

Historically, language and science overlap, but their ideal forms never touch. Language spans the expressive and the relational, beginning where expressive myth first takes on relational character, and ending where science demands that relational language renounce its last expressive elements. Language's fundamentally metaphorical and centrifugal features are incompatible with the ideal form of science. Speaking of their ideal inner forms, science begins only where language ends, where we discard metaphorical speech and demand explicit and unambiguous definition of terms.[38] This kind of clarity begins with the explicit definition of axioms and deductions, such as we see in Hilbert's geometry and Dedekind's number theory. In such systems, all individual terms are defined through their place in the overall structure (see. §3.4 above).

Just as myth was defined by the principle of *pars pro toto*, and language was defined by the endlessly growing chasm between expression and expressed, the guiding light of science is the dialectical tension that is sustained between series form and series member. This tension defines both series form and series member, as we've seen time and again in §3, because neither has any purpose but for its application through the other, and yet the two cannot be collapsed.

In the transition to science, we certainly gain in theoretical understanding. The newfound freedom to throw off the heavy mantle of expression is certainly a liberating feature. However, this freedom does not come without a cost. The metaphorical character of language was the last vestige of mythic expression, and it was in myth that we started out in a personal world, a world of "you" before "it." The scientific world is resolutely a

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[37] Like all forms, science must take its lead from its predecessors (PSF III, 443–444). Symbolic formation is not an arbitrary or an absolute enterprise, but has an irreducibly historical dimension, as we shall see in §4.5.

[38] On science emerging from language through the demand for unambiguous clarity, see (PSF I, 81–82; PSF III, 109–110; PSF III, 337–353; PSF IV, 217–218; Cassirer 1925, 97–98; Verene 2011, 25–27).

world of "it," where you and I never appear except as inert, dispassionate objects. The transition to science is thus essentially dehumanizing.[39]

Science drops the metaphorical character of language, but by focusing explicitly on relational structures, it also inverts language. The relational structures of language always emanate from the speaker, and so its relations are centrifugal, always radiating outwards from the subject at its centre. The structures are always *for* the subject. In science, the relations themselves take precedence, and the subject becomes just another location within that structure. Scientific structures are centripetal, exerting force inward on the subject from outside.

One of the greatest strengths of science is that it is able to freely set coordinate systems. How else would one describe the overwhelming brilliance of the general theory of relativity but to show us how such systems interrelate, thereby making it completely immaterial how one chooses to orient one's coordinate system? What for science is a blessing is a curse for myth. In the mythic world, essences reign, and spaces and times are not all equal, interchangeable. The freedom that science claims for itself is the greatest blasphemy for the mythic world: equating, and thereby negating, the sacred and the profane.

§4.5 Leben und Geist

In §4.3, we ran through a transcendental analysis of the three symbolic functions: expression, representation, and signification. In §4.4, we gave a very rough dialectical sketch of the phenomenology of the three main symbolic forms: myth, language, and science. In §4.5, I'd like to give a transcendental analysis of that phenomenology. That is to say, I'd like to explore the conditions of possibility for forms emerging out of one another. This is Cassirer's metaphysics, articulated most fully in his incomplete *Philosophy of Symbolic Forms, vol. 4: The Metaphysics of Symbolic Forms*. Because the articulation of his metaphysics remained fractured and unpolished, any presentation of

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[39] On the dehumanizing nature of science, see (PSF II, 73–75; PSF III, 67–78; PSF IV, 144; Cassirer 1979, 184–185; Krois 1987, 139; Verene 1999, 122–123; Skidelsky 2008, 119; Leroux 2010, 27; Verene 2011, 21). In fact, the mind–body relation is Cassirer's prototype for the inherence of meaning in the sensuous (PSF III, 94–100; Krois 1999, 531–532), thus making it unsurprising that the proliferation of scientific theories still has trouble locating the mind physically: the mind exists in expressive not scientific space, so to look for it in the latter is futile. On the mind–body problem, see especially (Ikonen 2011). David Mermin, a famous solid-state physicist, calls for "the Now" and the scientist as subject to be recognized as important parts of the practice of science itself; but the present moment is just one among others, and the scientist is just another physical object, so far as the symbolic form of science is concerned. His call is thus fulfilled through the overall symbolic forms project: the recognition of other forms of experience beyond science. Is the expressive, the self, absent from the modern world? No, it is retained in the symbolic forms of language, religion, and especially art (Cassirer 1979, 149–157). Though myth and science are absolutely opposed, the system of symbolic forms preserves that tension and neither need be relinquished.

this material involves a good deal of reconstruction on Cassirer's behalf. Let's jump right in.

There are three main elements to Cassirer's metaphysics that I'd like to explore here. The first two are *Leben* and *Geist*, or, "life" and "spirit." The third is symbolic formation, which we have already explored in some detail, but to which we will return once again to clarify its relationship to life and spirit. What is life? It is absolutely formless, totally immediate. It is pure material, ardently opposed to form, but also the ground in which form finds itself. Notice here the dialectical tension that is already being set up: life is completely resistant to form, but form has no meaning except in life. This is because life and form are only extricated from one another through analysis; they are two accents that we fix in a process that essentially involves both of these moments. But we never actually arrive at either of these poles, and they are more helpfully regarded as directions than as locations.

But what is this form into which life is forced? It is spirit. Spirit is the fixity to life's fluidity. The aim of spirit is to contain and channel life, to give it structure. Spirit shapes life, and though their natures are totally opposed to one another, spirit can only see itself mirrored in the matter of life. Spirit is culture. Life seeks to turn back on itself, to hold itself at a distance so that life can inspect itself. This holding at a distance is accomplished through the spirit. Life and spirit each seek themselves, but can only do so through their opposite. Life and spirit could not be originally alien to each other, as no subsequent bridge could span the gulf between them. Instead, they must be defined by the dialectical tension in which they exist.[40]

The dialectical back-and-forth between life and spirit is the seeking of the ideal in the real, and of the real in the ideal. But neither real nor ideal is severed from its opposite, and neither has any alternate purpose but to find its other, and to find itself in its other. Cassirer thus does not seek for the unity of consciousness in the transcendental ego, as Kant did; neither does he seek it in an idealistic overworld, nor an animalistic, impulsive underworld. Objectivity can only be explicated as a unification of life, a unification that takes place through the action of spirit. This unification, objectivity, is something that we explore within experience itself. Objectivity is not beyond experience, but rather within it. In experience, we find both life and spirit already entangled (PSF I, 88; Cassirer 1927, 425; 1979, 166–170).

Each symbolic form is a mediation between life and spirit. Symbolic forms are the medium through which life can look back on itself through spirit, and the medium for spirit to preserve and refresh itself through its application in life. Symbolic formation, the activity rather than the product, is the motor that drives this dialectic. This form-giving

[40] For more on the definitions of life and of spirit, see (PSF III, 413–415; PSF IV, 15–19; PSF IV, 219–220; Cassirer 1949, 863–870; 1979, 193–194; Verene 1982, 141; Cassirer 1983; Krois 1987, 66–77; Bayer 2001, 41–58; 2008, 103–104; Verene 2011, 64–66).

activity is essentially definitive of consciousness, making consciousness what it is. The product of this activity is culture, and culture is the symbolic forms.[41]

Spirit is the transcending of life; but as we have seen, the dialectical development of these two is encountered at every moment within conscious experience. Therefore, though spirit is the transcending of life, we also find it in immediate contact with life. Here we find an important clue to understanding Cassirer's distance from Kant: the immanent and the transcendent are both present in consciousness. The transcendent object, the unknown X beyond, is not a substantial, metaphysical postulate for Cassirer. Transcendence and immanence are both present to consciousness, as the immanent is in the transcendent and vice versa. Both are present in the symbol, which is the primary phenomenon of consciousness.[42]

Life, spirit, and symbolic formation, which is the energy that pushes the life–spirit dialectic ever forward, are all what Cassirer calls "basis phenomena." A basis phenomenon is something totally primary, totally irreducible. It cannot be explained, if explaining means to reduce it to a better-known thing, because nothing is known better. A basis phenomenon is something with which we are all immediately familiar. Life and spirit are first principles, known through their tension, which is definitive of consciousness itself. While they cannot be set upon a more primary foundation, we can explore their development. Life, spirit, and the tension between them that is the energy of symbolic formation: these are the conditions of possibility for the phenomenology of culture.[43] While we cannot inquire into the conditions of possibility for these basis phenomena, we can still inquire into their phenomenological development. That is to say,

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[41] For more on consciousness as symbolic formation, and culture as its product, see (PSF I, 61; Bayer 2001, 48; 2001, 59).

[42] For more on the immanent and the transcendent inhering in the symbol, and thus both being present to consciousness, see (PSF III, 385; PSF IV, 9; Krois 1987, 67–70; 1987, 150; Bayer 2001, 51–56; Verene 2011, 73). The interrelation of transcendence and immanence also elucidates the meaning of the *a priori* in Cassirer: the *a priori* is just the structure that we discover through transcendental analysis, that structure that makes experience possible. This structure undergirds experience, but it is no object; it is a function (Krois 1987, 38; 1987, 121; Verene 2011, xv).

[43] See (PSF I, 106; PSF IV, 15; Bayer 2001, 45; 2001, 69). Note that Cassirer discusses many basis phenomena, not just these three. What defines a basis phenomenon is this feature of being incapable of further explanation. We can give no conditions for their possibility, as it is only through them that anything whatsoever even exists. That criterion defines the basis phenomenon. We can, however, ask about the dialectical development of these basis phenomena in the course of cultural phenomenology. Cassirer's discussion focuses primarily on the basis phenomena of "I," "action," and "work." I will not discuss these three here, as I see them having more to do with the definition of man, as Cassirer explores primarily in his later works, especially the *Essay on Man*. For more on the basis phenomena, especially "I," "action," and "work," see (PSF IV, 127–142; Bayer 2001, 107; 2001, 130–152; Verene 2011, 66–70).

we can give a dialectical analysis despite the fact that the way is shut to transcendental analysis of these phenomena.

Cassirer's discussion of the phenomenological unfolding of the forms shows how strongly he has been influenced by the philosophy of language of Wilhelm von Humboldt. The latter claimed that the proper way to understand language is as an *energeia* not an *ergon*, that is, as a shaping power rather than as a fixed shape. Language renews itself through use, and every time it gets used, it changes slightly. However, while the fluidity of language is emphasized in the constant process of reshaping through use, that use itself relies on the stability of meaning. When we use language, we rely on a bedrock of established meanings; but that usage itself has an effect on the bedrock. Language must always have a history in order to be meaningful, but that history is subject to change as it continues to be used.[44] This back and forth between freedom and constraint, the relationship between *energeia* and *ergon*, shows how von Humboldt has influenced Cassirer's conception of dialectical unfolding, especially in language.

The same observations hold true for all symbolic forms. Their meaning is reliant on their history, on an established form of meaning, but that form itself is constantly in motion because the forms themselves are constantly in use. Symbolic formation shows a balance between solidity and fluidity. Symbolic forms are never empty, as they are always forming something; but neither is there a completely inert, shapeless, unsymbolized matter to fill those forms. We often distinguish between the symbol and the symbolized, but no such clean delineation is possible here (Cassirer 1927, 416; Verene 2011, 14). Form and matter are both already symbolic. As *energeia*, the symbolic forms are a reshaping energy, but they are constantly reliant on their stable history, their *ergon*, to make possible the application of that energy. The symbolic forms are constantly taking up new matter, but that matter is charged with symbolic history. Symbolic formation, consciousness, is the energy that takes up formed matter and gives it new form. Symbolic formation is thus always historical,[45] and never-ending (PSF IV, 9).

§4.6 Traditional problems in Cassirer scholarship

In this section, I would like to treat a few recurring concerns that arise in response to Cassirer's work. The issue of the grounding of the symbolic forms, of where this ideal edifice ever touches its feet to the ground of reality, is a problem that has come up time and again in Cassirer scholarship. Commentators worry that the mind is totally self-involved and never needs to respond to the demands of the real world, concerned that his picture of reality reduces to mere mental exercise and that somehow the mind is totally

[44] On language, and other forms, as *energeia* and as *ergon*, see (PSF I, 161; PSF IV, 16; Bayer 2001, 77; Leroux 2010, 10–21).
[45] For more on the historicality of symbolic formation, see (PSF I, 57; PSF IV, 21–23; PSF IV, 228; Hartman 1949, 292–293; Krois 1987, 73–75; 1987, 122; Schmitz-Rigal 2009, 86; Orth 2011, 121–122; Hoel 2011, 190).

out of touch with the actual demands of the world. They're worried that the world never gets a chance to push back against the mind.[46]

Is this a world completely dominated by caprice? Could we simply think a new world and have it appear? No, Cassirer is an empirical realist: he doesn't deny the existence of a world of experience, something we find around us that is not of our creation nor completely subject to our will.[47] This kind of voluntaristic metaphysics would require that the mind (or the will) has complete power over the world of experience. But Cassirer obviously could endorse no such thing, as the mind and the world are originally intertwined, and only gradually disentangled. The mind and the world both push against each other, defined by the tension between them. Experience is primary, and always involves both mind and world, which are gradually isolated from each other through analysis.

Perhaps the worry about voluntarism arises elsewhere: it is spirit that disentangles the mind and the world, so perhaps the concern is that spirit is given too much power in this relationship. (As the mind emerges through the action of spirit, it could not be that spirit is dominated by the mind.) Does spirit totally dominate life; does life get no opportunity to push back? Once again, the answer here is no; our world of experience is the meeting point of life and spirit. We cannot begin from either of these poles and reach out towards the other, because such a grasping would always fall short of its target. What pushes back against the forming energies of spirit? The matter of life. But in practice, the matter of life is already shaped by the powers of spirit, so what resists the spirit, what holds it back from completely taking this whole dialectic under its powers? The faulty assumption in this line of reasoning is that pure spirit ever arises, completely divorced from life. Dropping this assumption alleviates the concern. There is no pure spirit, devoid of all content, so we need not worry that any such thing completely dominates life without any opportunity for life to push back.

The pure formality of spirit is opposed to the pure materiality of life. But we encounter neither of these idealized poles in real experience; they are directions or orientations, not substances. Yes, the material we shape in experience is always, from the first, being formed by the energies of spirit. But, equally, the forming energies of spirit are always, from the first, being given particular direction by the matter of life. Symbolic formation is always subject to historical demands. Theory-laden experience and experience-laden theory push against each other (Schmitz-Rigal 2009, 85). There is no science, for instance, in a historical vacuum; theorization is always responding to certain historical demands, as we saw in discussing the relationship between the three levels of statements in science (§3.5 above). If this historical dialectic required grounding through pure life or

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[46] In his review of the *Library of Living Philosophers* volume on Cassirer, Jenkins does an excellent job synthesizing the major concerns about Cassirer's work. This particuar concern arises in (Jenkins 1950, 44). For more on the concern about pushback, see (Swabey 1949, Leroux 2010, 51; Verene 2011, 62–63).

[47] For Cassirer's explicit statement of empirical realism, see (1979, 195).

pure spirit, we would be forever lost to skepticism, because neither of those is ever available to us in experience, in reality.

The dialectic is grounded by the history itself, with past theories presenting demands that subsequent theories must fulfill. The successor theories in turn are expected to encompass their predecessors, explaining their successes as well as their shortcomings. This historical grounding is as valid for stages within scientific development as it is for science as a stage within the phenomenology of culture; each symbolic form is dependent on its place within the whole phenomenology for its grounding.

This recognition is the major payoff of the metaphysics of symbolic forms. Given the transcendental analysis of each symbolic form, and the dialectical analysis of their phenomenology, we still need the transcendental analysis of that phenomenology itself to ground the whole thing. Only in recognizing how the symbol plays a mediating role between life and spirit, and how that relationship provides the conditions of possibility for the phenomenology of culture, does that phenomenology itself find its grounding.

Verene, responding on Cassirer's behalf to the worry about how the world can push back against the mind or against spirit, says that this concern does not address Cassirer specifically. Rather, the dependence of objects on the mind is simply a feature of idealism in general, which needs defense. It therefore does not fall to Cassirer alone to respond to this worry (Verene 1969, 45). I think that this response sells Cassirer short, in addition to miscasting him as an idealist. The dependence of objects on the mind is only half the story, because the relationship is symmetrical, truly one of codependence. Thus, Verene makes Cassirer at least partially answerable for a problem in idealism, whereas Cassirer himself can deploy his structure of codependence in response to the concern, an option not available to idealists. Verene therefore concedes too much in claiming that the general worry about idealism is not specific to Cassirer.

So, is the mind given too much power over the world? Does this worry apply to Cassirer? I do not believe that it does; or at the very least, a more specific and convincing charge must be leveled at him. The mind and the object are interwoven, each being dependent on the other only because they are interdependent. It is the activity of spirit that carries out the gradual disentangling of mind and world. And the mind is not total master of spirit, so the worries about idealism don't clearly apply at this juncture either.[48]

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[48] A related worry is that Cassirer's phenomenology of culture is completely insensitive to economic, geographical, and natural forces (Jenkins 1950, 52–53). It is true that he barely discusses such forces, that culture sometimes appears as a clean machine, requiring no energy from outside; but because of the explicit interconnection between life and spirit, and between mind and world, I think that there is ample room to discuss the role of such forces. Cassirer himself does not discuss them, but nowhere does he appear to preclude their applicability or even their importance. Jenkins's point is well taken, though: these forces are undoubtedly important, and their inclusion in the symbolic forms project would be a major contribution.

Carl Hamburg, in his chapter of the *Library of Living Philosophers* volume, asks in what sense the symbolic forms constitute reality (Hamburg 1949, 77–84). Specifically, are spirit and life mediated by the symbolic functions (i.e.: expression, representation, signification), by the symbolic forms (myth, language, science), or by the categories of space, time and number? In light of the discussions in this chapter, we can clarify matters considerably for Hamburg. Symbolic functions, symbolic forms, and the categories are all necessarily involved in the constitution of reality. But surely we can be more specific.

Life and spirit are necessarily mediated by symbolic forms, but myth, language and science are not exhaustive of such forms; Cassirer explicitly mentions other forms, such as art, religion, and history. So, while one or another symbolic form is always necessary to mediate between life and spirit, that is, to play a constitutive role in reality, any form can take on that role. Myth, language and science are not alone in accomplishing that task. Each of these forms, however, draws on the symbolic functions of expression, representation and signification, so while *any* symbolic *form* can mediate between life and spirit, *all* of the symbolic *functions* are necessary for the constitution of reality. Lastly, because each symbolic form must give a characteristic tonality to the categories of space, time, number, causation, object and subject, all of these categories will necessarily be involved in the constitution of reality. (Hamburg listed only space, time, and number, but as we've seen already, the categories also include causation, subject, and object.)

In what sense is reality constituted through the symbolic? We can now give a complete answer to Hamburg's question. First off, a symbolic form is always necessary for the constitution of reality, for the mediation between life and spirit. This mediation is the role of the symbolic forms, and any of them can accomplish it, so we need not limit ourselves to myth, language and science. Secondly, the symbolic forms always draw on all three symbolic functions. Lastly, each symbolic form shapes space, time, number, causation, object and subject. So the constitution of reality requires a symbolic form, which uses an admixture of the three symbolic functions to arrange its characteristic tonality of the six categories.[49]

Probably the most weighty and constant criticism of Cassirer is that he postulates a very unstable tension between the equal importance of all the symbolic forms and the primacy of science. His reverence for science, developed in his early Marburg years but never dissipated even in his later works, stands in stark contrast to the claimed equality of all the symbolic forms. How could they all be equal if science is more equal than all the others? This is a pressing concern indeed, but ultimately some clarification will show it not to be fatal. The role of the symbolic forms, as we've seen, is to build a world, to mediate between spirit and life. Each symbolic form accomplishes this task according to its own fashion, and can be measured only by its own standard. But despite this variation

[49] Verene expresses two concerns about myth, which do not pertain closely enough to the present context to warrant full treatment, but are interesting in their own right. The first is about the degree to which Cassirer's work on myth is applicable to primitive peoples in the modern world (Verene 1966, 560–562). The second is about whether Cassirer leaves any room to differentiate between conception and imagination (Verene 1982, 143).

of style each form is equally suited to the task of worldbuilding. That is what it means to assert the equality of the symbolic forms. The forms are equal in rank, but not interchangeable, avoiding metaphysical one-sidedness as well as relativism.[50]

What is "one-sided metaphysics," and why does Cassirer take such pains to resist it through the deployment of so many arguments in his later work? Cassirer's own metaphysics embraces dialectical tension, as we've seen. The relationship between life and spirit is characterized as one of tension. The same tension arises between mind and world, between the individual symbolic forms, between symbol and symbolic form, between series member and series form, etc. As we saw in §4.5, Cassirer resists the temptation to repose his philosophical edifice on the foundation of a transcendental ego, a world of pure ideas, or a world of pure willful drive. Rather, his philosophy emanates outward from the tension between sensuous and intellectual, between life and spirit, which one finds within the symbol. This is no will to power; it is a will to form (PSF IV, 28).

One-sided metaphysics is any attempt to take one moment of a dialectic and make it dominate the whole relation, thus dissolving its characteristic tension. One-sided metaphysics makes one dialectical pole into the basis of reality. For instance, Cassirer goes to great pains in PSF IV to argue against *Lebensphilosophie* (of which Heidegger is the prime representative) because he sees it as one-sided metaphysics. His concern with Heidegger is that he is attempting to make life absolutely primary, rendering spirit subservient to it, which we see most clearly in Heidegger's writings on the concept of thrownness (*Geworfenheit*).

As we have seen, Cassirer argues that life and spirit are only ideally separable, that we never encounter one without the other. So what Heidegger describes as the world of life already contains spirit; the basic experience described in Heidegger's philosophy already contains the spiritual elements he seeks to root out. But even if it were possible, even if Heidegger were successful in distilling a life completely devoid of spirit, this life would be inert, distorted. The characteristic feature of life turning back on itself, via the detour through spirit, would be an impossibility. Life itself is undermined by the abandonment of spirit!

Similarly, Cassirer worries that Hegel's idealism makes all moments of spirit subservient to the Absolute Idea towards which Spirit is always tending, and in which the tension between all prior moments is dissolved rather than preserved. The worry here is that spirit is always historically grounded, and that if each subsequent moment negated the moment that came before, if dialectical tension were not retained, then each moment of spirit would negate its own grounding. That is why Cassirer denies Hegel's *Aufhebung*.[51]

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[50] For a more comprehensive, yet still tidy, elaboration of this point, see (Krois 2011, 19).
[51] For more on Cassirer's distance from Hegel, see footnote 8 above. On whether this interpretation of Hegel's *Aufhebung* is appropriate, see footnote 3 above.

In light of this resolute opposition to one-sidedness, how can Cassirer carve out a privileged place for science? At first glance, it might seem that Cassirer is privileging one moment of spirit over the others, repeating the fault of which he accuses Hegel. Surely this privilege cannot be understood to mean that science has an inside track on truth. That would be completely incompatible with Cassirer's own commitments.

But there is another kind of privileged niche that Cassirer can prepare, and I suggest that this is the appropriate understanding of the role of science in Cassirer's philosophical architecture. Each symbolic form builds a world in its own way, and must be measured according to its own standard. But because of its characteristic dialectical tension between series form and series member, science has the greatest power to reveal to us the truly symbolic nature of reality. The dialectical tension that permeates Cassirer's work through and through is exactly the same kind of relationship that characterizes the scientific symbolic form. Of all the symbolic forms, it is science's *ergon* that most urgently announces to us that symbolic formation is actually an *ernergeia*.

Now we can untie the Gordian knot of the equality of forms and the primacy of science. Each of the forms mediates between life and spirit, each creating a world according to its own standard and appropriately measured only by that standard. They are thus on equal footing, each equally able to build a world. But there is also a reflexive quality that is stronger in science than in any other form, the quality that helps us not only to build a world in which we live, but to recognize ourselves as world-builders, to see as clearly as possible the dialectical tension that characterizes our relationship with the world. The equality of forms pertains to symbolic worlds they each create; the primacy of science pertains to its reflexive quality, both building a world and announcing itself as a world-building energy.[52]

Cassirer's opposition to one-sided metaphysics can make clear his relationship to many positions in contemporary philosophy.[53] His famous encounter with Heidegger at the *Hochschulkurse* in Davos, Switzerland, 1929, as well as Heidegger's prominence in Germany during the rise of Nazism, attracted a great deal of Cassirer's attention. Receiving somewhat less attention was the burgeoning Vienna Circle, and especially their adoption of Wittgenstein's linguistic turn. Cassirer never clearly delineated his position in relation to positivism (Hamburg 1949, 81), and in fact likely never read Wittgenstein (Skidelsky 2008, 142–146). However, in retrospect we can clearly see that he would not have endorsed their project. Put simply, Wittgenstein's linguistic turn

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[52] For more on this problem of equality of forms and primacy of science, see (PSF I, 41–58; PSF II, 25–26; PSF III, 13–14; Jenkins 1950, 49; Krois 1987, 7; Verene 1993, 119–120; Schmitz-Rigal 2004, 2–6; Skidelsky 2008, 113–122; Schmitz-Rigal 2009, 76; Krois 2011, 19; Verene 2011, 46).

[53] In a fascinating passage, Cassirer retraces the history of metaphysics and the history of epistemology as committing again and again to one-sided positions, setting now this and now that as the foundation stone. See (PSF IV, 167–189; Bayer 2001, 153–155; 2001, 170–190). For more on the resistance to one-sidedness, see (PSF IV, 24–31; PSF IV, 104; Hamburg 1949, 93; Krois 1987, 122–123; Bayer 2001, 50; 2001, 95; 2001, 112).

focused solely on the propositional, representative feature of language, at the expense of the expressive.

Cassirer's own symbolic turn goes one level deeper, establishing the symbol as primary instead of the proposition, allowing both the expressive and the propositional features of language to be retained as different, but equally respectable, symbolic features of language. The linguistic turn is thus shown to be just another facet of one-sided metaphysics, setting up the proposition as the basic unit of reality. The symbol is not one-faceted but rather plays an essentially mediating role between the meaningful and the sensuous, and so establishing the symbol as the basis of his philosophy should not be seen as one-sidedness on Cassirer's part.

The eradication of expression is seriously problematic. Recall that the expressive function is where we first encounter other people, and that in science, the complete rejection of expression (through the demand for clarity) has a de-humanizing dimension to it. Thus the problem of other minds arises when we suppress the expressive function, and will not be resolved until we acknowledge this fact and follow Ariadne's thread back to the point at which we erred.

For Cassirer, the symbol is always primary. Hence, we find that propositions are secondary to meaning in general, of which propositions are just one kind.[54] Thus, the symbolic turn subsumes the linguistic turn, showing propositions to be too specific to encompass all meaning. Science is also but one form of the symbolic, and thus scientific causation cannot be prior to meaning itself.[55] Consequently, all attempts to give a naturalistic explanation of meaning will ultimately end in circularity. Meaning is prior to class logic too, as it is only in virtue of symbols, of meaning, that elements can be arranged into classes.[56] Class logic will thus prove similarly fruitless in attempting to explain the genesis of meaning.

Circularity arises once again when one attempts to explain meaning via conventionalist avenues. Meaning is a precondition for communication, and communication is a precondition for agreement, which is in turn a precondition for convention. Thus, convention could not be the ground on which meaning is originally established. In fact, the circularity begins one step lower: communication depends on individuated subjects, and meaning is a precondition even for such individuation. In the absence of meaning, not only could subjects not come to an agreement about establishing a convention, there would not even be individuated subjects to attempt any such endeavour. Therefore, conventionalist theories of meaning must be rejected.[57] Cassirer opposes all one-sided philosophy, showing each form of it to end in circularity.

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[54] (Krois 1987, 24; 1987, 62; Schmitz-Rigal 2009, 79; Heis 2010a; Krois 2011, 9)
[55] (PSF III, 197; Krois 1987, 63–64)
[56] (PSF III, 292–302; §3.3 above)
[57] (PSF I, 105–6; Krois 1987, 45–53; 1999, 537; Leroux 2010, 22)

§4.7 So, what about those realists and empiricists?

Getting back now to the dispute between realists and empiricists, what have we gained in this chapter? Recall that in the first two chapters, we sketched positions along the realist–empiricist spectrum, recognizing finally that all those positions agree on the mind-independence of the world. Cassirer's arguments against abstraction, which form the basis of his philosophy of science, ultimately indict the assumption of a mind-independent world. Thus, he cannot be aligned with any empiricist or realist position (including structural realism). But we shall not leave this void empty.

In the present chapter, we have explored Cassirer's full philosophy of symbolic forms, his positive project. That includes an account of symbols, which are always a two-in-one of the sensuous and the meaningful. Additionally, we saw that these symbols take their meaning from their place in symbolic forms, each of which is a total worldview of its own. Symbolic forms draw on the functions of expression, representation and signification to delineate their unique character, and each form thereby gives a specific tonality to the categories of space, time, number, causation, object, and subject.

Using the forms of myth, language and science as the foremost exemplars of the three symbolic functions, we then went on to explore their phenomenological emergence from one another. We discovered that each form is justified by its place in this dialectical unfolding, where each form is justified by fulfilling the demands of its predecessor, but sets demands of its own, which are satisfied in turn by the form that follows after it. Each of these symbolic forms is a mediation between life and spirit.

Symbolic tension always threatens to resolve; one pole of a given relationship always threatens to collapse into primacy, its energy imploring us to establish it as the basis of all reality, on which the rest of reality is built as a secondary construction. But we have seen that, phenomenologically, each symbolic form is necessary to ground the whole. Furthermore, we have seen that, transcendentally, each symbolic function is necessary to comprehend symbolic pregnance. One-sidedness thus always threatens the cohesion of experience and objectivity, and we have seen that one-sided theories again and again lapse into circularity.

The supposed mind-independence of the world is just another example of one-sidedness. It is the representative function, so prevalent in language, that posits the ultimate alterity of symbol and symbolized object. The fault of representationalist epistemologies, including realism and empiricism, is to assume that, because the individual word can never break through language to grasp the object directly, knowledge as a whole must be in the same predicament, seeking to grasp a world that is fundamentally independent from thought itself (Cassirer 1927, 421). But the relationship between mind and world is one of dialectical tension, in which the two are completely intertwined and codependent. The world is not alienated from the mind just as the mind is not alienated from the world. Each depends on the other and constitutes the other. The mind-independence of the world

must therefore be supplanted by the codependence of mind and world, by the mediation of life and spirit through the symbolic forms, including but not limited to science.

Cassirer rejects both realism and idealism, the primacy of either the world or of the mind. If he is accused of idealism but not of realism, this reflects the fact that there are simply not enough truly committed idealists out there to take umbrage.

Recall from way back in the first two chapters that the debate between realists and empiricists these days is primarily motivated by the Miracle Argument and the Pessimistic Induction. How does Cassirer's philosophical work respond to these two arguments? According to the Miracle Argument, the success of science would be completely miraculous if science were not identifying the real furniture of the mind-independent world. A one-sided metaphysics that postulates a mind or a world that stands on its own, or an absolute gap between life and spirit, would definitely need a miracle to sew the pair back together.

But for Cassirer, we start from the fact of experience, in which the mind is always involved in the world, and spirit is always full of life. He rejects the independence of mind and world. Success is no miracle because we are always approaching the world from a particular historical situation, responding to particular questions from a particular background of theoretical assumptions. No miracle is needed to sew spirit and life back together because they were together already. A symbolic form is a reshaping *energeia*, but it always depends on its stability as an *ergon*. The world and the scientist are progressively disentangled from one another through the course of symbolic formation; neither begins independently of the other, and thus no infinite leap is required to span the gap between them. What we see here is that Cassirer isn't offering up a miracle; he's obviating the need for one, by rejecting the assumption of mind-independence at work in realism and empiricism. The scientist is not tracking the mind-independent world; she and the world are being disentangled as each responds to the other.

The Pessimistic Induction draws on the history of science, showing that (certain) past theories in science have been successful despite eventually being rejected in the course of theory change. From this, the empiricists claim that the success of a theory should not be considered evidence of its truth. Cassirer would be happy to embrace this point. Again, the historicity of science is totally in line with this empiricist argument: for Cassirer, science is always a response to a particular set of historical questions and is always starting from a certain theoretical foundation. At each stage of science, we are addressing the questions of the previous stage and setting up the questions for the next stage. Do we see discontinuity here? Sure, so long as the discontinuity at any one level of scientific statement (i.e.: results of measurements, laws, and principles; see §3.5) does not disrupt the overall continuity of the three levels taken together. But, again, the world is not a finished thing, not a coagulated substance. The scientist has a role to play in shaping the world. Discontinuities in scientific theorization should therefore not be seen to shatter our brittle connection to the substantial world, but to announce the dialectical and motile tension between subject and world. Discontinuities in one or another level of statement

do not demonstrate that the scientist is operating "merely" in the world of experience as opposed to some mind-independent, finished, objective world.

Science is dialectical and historical. The fact that scientific history is already underway undermines the need for miracles. And the fact that this history is never finished undermines the need for pessimism. Both the Miracle Argument and the Pessimistic Induction are undermined by recognizing the codependence of subject and object.

Cassirer's arguments against abstraction show us serious flaws in the positions of contemporary scientific realists and empiricists, and his philosophy of symbolic forms presents an alternative framework that we can take up in place of the realist–empiricist dispute, a framework that even alleviates the tensions that motivated that dispute in the first place.

To be as clear and as direct as I'm able: Cassirer's philosophy of symbolic forms is not being presented here as merely a more attractive solution to the concerns that drive the realist–empiricist dispute. I mean to claim something stronger, that Cassirer's arguments in fact undermine the viability of any position along that spectrum.[58] How does that argument run, exactly? As covered in §3.3, the arguments against abstraction in fact cut deeper; they undermine more than just an abstractionist picture of concept formation.

Scientific measurement is characterized by two features that are salient for this argument: holism, and idealization. Measurements are holistic because we need to rely on a bedrock of laws in order to carry out any individual measurement. Recall the objection (in §3.3) against Lobatchefsky's proposed experiment: no experiment could determine whether light moves in straight lines through curved space of in curved lines through straight space. We need to hold a set of laws constant as a precondition for any experiment. Thus, experiments are not self-standing, individual. They exist in an already holistic system.

Idealization is also a constant feature of measurement, because we are never using the real, flawed instrument in making our measurement. We substitute for it an idealized one. There are no ideally straight rulers; there are mostly straight rulers, which we idealize in using them. Furthermore, we must always judge whether a measurement is "close enough." Measurement is simply taking the real and re-casting it in the ideal realm of numbers and laws. This always requires the introduction of idealizations, and judgments of adequacy. The length of real objects is always an irrational number.

The holism of laws and numbers means that no element of science is substantially distinct from the others. The system operates as an overall unity. The idealization that goes into

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[58] In discussion *a viva voce*, Anjan Chakravartty pointed out to me that this point was not entirely clear from the text alone. I had hoped that this argument would emerge organically from the whole of my writings here, but his point is well taken that a direct and concise presentation of this conclusion, and the argument supporting it, would be valuable. Many thanks for his insightful questions, and for his recommendation that I come back to this point once more, and in this manner.

measurement implicates the mind in the system: there is no individual fact of the matter in the absence of the mind's involvement. The implication of the mind in particular measurements is infused into the whole system by the holistic interconnection of particulars and laws (and, later, principles). In this way, a serious challenge is presented to the notion that the sciences catalogue a mind-independent world.

Given the characterizations of scientific realism and empiricism in the opening chapters of this thesis, the challenge to mind-independence is a challenge to the entire realist–empiricist spectrum as a whole. (Recall, in §1.5, footnote 25, that I explicitly stated that any realist or empiricist position *denying* mind-independence would not be targeted by these arguments.) But can realists or empiricists retrench; can they recast their positions in such a way as to avoid these objections? The final chapter of this project will be driven by that very question.

CHAPTER FIVE

§5.1 Taking a stand

In §3 and §4, we explored Cassirer's arguments against abstractionism, in which are contained arguments against the notion that there is a mind-independent world that arbitrates between true and false theories. That presupposition provides the foundations on which the realist–empiricist dispute is built. If Cassirer's arguments are accepted, then the current realist and empiricist positions are mortally wounded. Can the realists and/or the empiricists retrench, establish new frontlines on which to wage this battle? How does one retrench; how does one establish a new position as the extension of an ongoing tradition?

Van Fraassen, in his 2002 work *The Empirical Stance*, provides a very clear and articulate language (discussed very briefly in §1.5) in which we can cast this question: the language of doctrines and stances. Doctrines are sets of beliefs, "putative matters of fact," theories about what is true and what is not.[1] By contrast, stances are policies for forming such factual beliefs, instructions for how to build a doctrine. We can be right or wrong in the doctrines that we hold, because they ostensibly refer to facts. By contrast, "Policies are not themselves true or false… holding a stance is a function of one's values as opposed to one's factual beliefs, and though values may be well- or ill-advised, they are not true or false" (Chakravartty 2007, 17).

The realist–empiricist dispute up to this point, or at least as discussed in this dissertation, has taken place at the level of doctrines. The two camps have attempted to show that the doctrines of their opponents are incompatible with the practices of science itself, and therefore ought to be rejected. In brief, the strategy as depicted to this point has been to show that the factual beliefs of the opponent are just false, that the doctrine is not successful in its attempts to pick out facts. However, such a maneuver seems unlikely to ever land a fatal blow against the stance, which makes no factual claims and provides instructions for the retrenching of one's position.

Show me that my doctrine fails and I will simply fall back on my stance to provide a fresh interpretation, a new doctrine; and the battle rages ever forward. Show me that my stance is inherently and incurably flawed, on the other hand, and my position will unravel, like pulling at a loose thread. That's no easy task, however, as values are notoriously resistant to criticism. It surely would not be enough to show me that my stance is incompatible with yours. After all, if my belief-formation policies and yours are incompatible, that could just as easily indict yours as mine. No, what must be

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[1] This quoted phrase is in fact drawn from Chakravartty's treatment of the doctrine–stance distinction (2007, 17), which is a more succinct presentation of these ideas than van Fraassen's original. However, for those interested in going back over the original text, van Fraassen's discussion of the subject appears in the second chapter of his *Empirical Stance* (2002).

demonstrated is that my stance is in fact internally incoherent, that the problem with my stance is not its relation to any other stance, but rather its relation to itself.

Coming back to the matter at hand, we can see that Cassirer's arguments thus far have been aimed at the doctrines of the realists and the empiricists. Can the realists and/or the empiricists retrench? We can recast that question, using our new language, as asking whether the empirical stance and/or the metaphysical stance (i.e.: the stance underlying realist doctrines) can spit out a fresh doctrine to sidestep the concerns raised by Cassirer, or whether their stances too have been affected by the foregoing arguments. In order to answer this question, of course, we'll need a clear picture of their stances.

Let's start with the empirical stance. As van Fraassen characterizes it, the history of empiricism is the history of a struggle against metaphysical speculation, a recurring critique of metaphysics (2002, 36). How does this critique manifest itself? Three features constitute the empirical stance:

E1 – Reject demands for explanation in terms of things underlying the phenomena.
E2 – Reject attempts to answer such demands by speculating about the unobservable.
E3 – Follow, as a model of inquiry, the methods of the sciences.[2]

Essentially, empiricists will reject any attempts to use the unobservable to explain the observable (E2), and even reject the need for such attempts (E1). Instead of such metaphysical speculation, they just follow the methods of the sciences, allowing the sciences to do any explaining that's needed (E3). As we saw in §1, it is the implication of unobservables by the language of science that called for the development of logical empiricism and, later, constructive empiricism, which both sought to permit empiricists to use scientific language without thereby committing themselves to metaphysical speculation. It was the apparent incompatibility of E1 and E2 with E3 that required empiricists to develop a doctrine according to which the language of science could be used without committing oneself to unobservables.

Van Fraassen identifies a few neighbouring positions that, through their contrast, can help us to add some definition to our picture of empiricism (2002, 192–193). Materialism, according to van Fraassen, is the position that endorses the content of science (more specifically, of physics), as opposed to its form of inquiry. According to materialism, science/physics tells us what really exists in the world. By contrast, empiricism adopts the method of science, countenancing all hypotheses and allowing the facts to determine which is true and which false, and rejecting all hypotheses that surpass the empirical, that in principle could never be verified. "Truth and error are objective categories, handed to us by nature itself" (van Fraassen 2002, 87).

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[2] Again, this formulation is drawn from Chakravartty's presentation (2007, 19) of van Fraassen's idea. Van Fraassen only explicitly gives E1 and E2 as the defining features, but speaks throughout of empiricism as commitment to the "forms and practices of science" (2002, 63), as opposed to the content of science at any particular time. Thus, I think that Chakravartty's formulation is a fair representation of van Fraassen's idea, and treating the commitment to science as an explicit element of the empirical stance makes it easier to get a handle on what van Fraassen has in mind.

Secularism is another position in the same neighbourhood. Whereas empiricism claims that the methods of the sciences need to be given pride of place, that they are to be preferred, secularism goes further, claiming that science is comprehensive, totally sufficient all on its own and requiring no complement. While he sees this position as compatible with empiricism, van Fraassen explicitly identifies it as beyond the innermost limits of empiricism. An empiricist may also espouse secularism, but need not, and van Fraassen himself does not (2002, 193). So in sum, a materialist is anyone who forms their beliefs based on the *content* of science. An empiricist is someone who uses the scientific *method* of ruling on hypotheses as a way of arbitrating between potential beliefs. A secularist is someone who not only venerates science (either for its content or its method), but furthermore sees nothing beyond science as worth pursuing.

Turning now to the metaphysical stance underlying realist doctrines, here are the characteristics that define it most centrally:[3]

M1 – Accept demands for explanations in terms of things underlying the observable.
M2 – Attempt to answer such demands by speculating about the unobservable.
M3 – Follow the sciences as a model for discovering the real furniture of the world.

The kind of explanation called for in M1 we see exemplified in the sciences, say the realists. For example, the regular rotation of Earth around the Sun is explained by an imperceptible gravitational field, an attraction between the two massive heavenly bodies, which we cannot observe directly. However, sometimes even science turns out to be false in its speculation into what's going on below the observable surface, as was the case for instance with phlogiston theory. Neither the realists nor the empiricists are interested in completely unbridled speculation about unobservables, but while the empiricists eschew the practice as a whole, the realists use science as a way to canalize that speculation (damming it when necessary). The concern that most troubles realists these days is that even sometimes the channels of science run into bedrock through which we cannot dig; even science itself from time to time heads in the wrong direction and must retrace its steps and find another path for its waters to flow. This concern is the Pessimistic Induction all over again, and current realist doctrines are just new tributaries flowing from the metaphysical stance in light of revolutions in the history of science.

I would like to present one further stance, before moving on to discuss the virtues and vices of each. This last stance is the scientistic stance, championed by Ladyman and his band of structural realists. Their stance is not so much a resistant attitude towards speculation as it is a declaration of all-out warfare, a secretion of bilious, vitriolic hatred, a scorched-earth approach to the history of metaphysics. According to Ladyman et al., science is the only objective mode of inquiry, and the role of metaphysics is to play a unifying role for the sciences (Ladyman and Ross 2007, 5–6). By contrast, metaphysical efforts that overlook or overly caricature science have abandoned any quest for truth, and are therefore more akin to poetry and story-writing than to objective inquiry. The abandonment of science has created of metaphysics a "hermetically sealed" world, an echo chamber for one's own ideas, where no dissenting voice may speak and all hope of

[3] Drawn from (Chakravartty 2007, 18). As he added the deference to science, E3, to the empirical stance, so have I added an analogous element here, M3.

progress is in vain (Ladyman and Ross 2007, 13–14). Their stance is characterized by two features:[4]

- S1 – Metaphysical hypotheses can be justified only by the service they would perform in unifying objective science.
- S2 – The hypotheses of the special sciences are to be constrained by the hypotheses of fundamental physics, but not vice versa.

So far as Ladyman et al. are concerned, metaphysics plays only a secondary role, unifying that which is discovered through the sciences rather than speculating in one's armchair about the contents of reality. To employ van Fraassen's terminology, the scientistic stance is one of secular materialism.

§5.2 Stand back

Cassirer's arguments against abstraction, presented in §3.3, undermine the mind-independence claim that forms the basis of realist and empiricist doctrines. But what about their stances? Looking first at the scientistic stance, we can see that Cassirer's arguments will undermine this as well, and not just the structural realist doctrine that is derived therefrom. Cassirer's arguments against abstraction show that scientific theorization and measurement require an active contribution by the experiencing subject, that the world cannot be passively received. Nature, a coherent world of experience, is a task for the experiencing subject, rather than being an unproblematically given object.

But we must here push further. Why is science alone not enough to construct a world? Scientism proudly announces that science on its own is totally sufficient, and would reject any call to recognize the claim to validity of other symbolic forms, myth and religion perhaps most of all. Their rejection of other forms must be shown to be incompatible with science itself, if we are to turn them from that path. The flaw must be shown to emanate from within the stance itself, not from outside.

In §3, we saw that science justifies theories by subsuming them under their successors, for example, that Newtonian mechanics emerge as a limit case of general relativity. Just as Newton's work was justified by situating it within the broader invariant theory of physics, so too did we call for science itself to be justified by situating it as a limit case of an invariant theory of experience. This argumentative approach likely isn't strong enough: even though the symbolic forms project *in toto* in fact offers just such an invariant theory, the adherents of scientism may yet refuse to acknowledge the need for any such situating.

A refusal to acknowledge the need would seem disingenuous. They recognize the importance of exactly the same contextualizing move within science itself, so to reject a parallel move to contextualize science as a whole seems to be applying different measures to similar problems. However, pointing out disingenuousness is not always a successful rhetorical strategy, so let us push further. While the demand for an invariant

[4] Ladyman and Ross define their stance (2007, 64) as the conjunction of the Principle of Natural Closure (PNC, labeled S1; defined in 2007, 37) and the Primacy of Physics Constraint (PPC, labeled S2; defined in 2007, 44).

theory of experience played a stylistically useful pivot point from §3 into §4, the material presented in §4 itself provides stronger arguments against scientism. Specifically, I will present two reasons why the symbolic structure of science, which Cassirer constructs simply by analyzing scientific practice itself, measurement in particular, necessitates the other symbolic forms.

The first reason is that (a) science draws from the well of symbolic pregnance, as all symbolic forms do. Symbolic pregnance, recall, encompasses all three symbolic functions: expression, representation, and signification (PSF III, 199; Hoel 2011, 82–83). Expression is best exemplified in the symbolic form of myth; representation is best exemplified in the form of language; signification is best exemplified in the form of science. All the symbolic functions are involved in all the symbolic forms, but it is only through their prominent exemplifications that we can recognize the particular character of each function as such. What does all this say about science? To understand science requires understanding symbolic pregnance, the inherence of meaning in sensuous symbols; it is only the connection between the meaningful and the sensuous that grounds the application of mathematics to the objects of common-sense experience. Rejecting all symbolic forms other than science, we deprive ourselves of the archetypes of the symbolic functions of representation and especially of expression. This privation ultimately limits our understanding of symbolic pregnance in general, on which science draws.

Put simply, Cassirer's arguments against abstraction show that science is a world-making endeavour. Holding science as the only legitimate form of world-building undermines our ability to understand symbolic pregnance, the ultimate foundation of world-building in general, and thus erodes our understanding of science itself. We need all three symbolic functions to understand symbolic pregnance, and we need all of the symbolic forms in order to understand those symbolic functions as best we can, in order to best clarify the function that science itself fulfills.

The second reason is that (b) science is justified historically, phenomenologically. Just as scientific theories are justified by their historical setting, with successor theories answering questions posed by their predecessors, and predecessor theories finding their place as explained by their successors, so too is science as a whole justified by its ability to answer questions posed by other symbolic forms. The parts of the symbolic universe are justified by their place in the totality, by the equilibrium created when each form exerts a pressure on the whole. Recall from §4.4.2 that science emerges from two linguistic worlds colliding, with each making a claim to the unique world of facts. It is the ability of science to respond to this crisis that provides the dialectical justification of science. To remove or undermine the legitimacy of any part of this totality would destroy the internal equilibrium that justifies each of the parts.[5]

[5] For more on myth as the phenomenological taproot of the symbolic forms, see (PSF II, xiii–xiv; Cassirer 1925, 44; Verene 1982, 139; Bayer 2001, 103–105; Skidelsky 2008, 115–117; Verene 2011, 32–36).

Again, to put it briefly, science is supposed to save or organize the phenomena. But those phenomena themselves predate science. They don't come from nowhere. Where do those phenomena originate? We already separate between reality and illusion before science enters onto the scene, even if that judgment is subsequently revised. The initial judgment comes from the symbolic worlds of language, myth, art, etc. The world is not passively received, but actively created, and always according to one or another symbolic form. Scientific research comes to a world of phenomena and begins its work of measurement and systematization. As there are no unproblematically given objects, events, etc., science would have no world to measure if there were no other symbolic forms. Science is justified by the work that it carries out in the phenomenal world, by answering the questions that are befitting of its unique character. Without the other symbolic forms, without the questions that they pose, science would have no work to do and no task to justify it. Science itself thus requires that the other symbolic forms be acknowledged as legitimate, lest the grounds of its own application be swept away. Scientism thus cannot be justified; science seems to demand undivided attention, but Cassirer's analysis of science itself shows that it necessitates looking beyond its own boundaries.

Ladyman's version of scientism decries idle metaphysical speculation, demanding scientific rigour and precision. Metaphysics has only one job: to unify. However, what Ladyman and company fail to recognize is that they themselves are guilty of the very speculation that they so heavily deride. They have divided *a priori* that which merits unification from that which does not. Metaphysics must unify science, but it must unify far more as well, and the limitation imposed by the scientistic stance is *ad hoc* and arbitrary, presupposed from the outset. A more careful look at science itself shows that it must be unified with other forms of experience as well. Ladyman and Cassirer agree that metaphysics must unify; but they disagree on the material to be unified. Only Cassirer, however, offers an argument for his delineation of the material to be unified, and that argument begins from examining science. Scientism must show that his arguments fail; or else the stance disintegrates.

The problem with scientism is that it insists upon the sufficiency of science alone, to the exclusion of any other type of inquiry, whereas the grounding for science itself requires that which lies beyond scientific boundaries. Does this same incompatibility arise for the metaphysical and empirical stances? No: both the metaphysical stance and the empirical stance include a clause about the deference to science (M3 and E3, respectively), but neither insists upon science as the sole and unique respectable form of inquiry. Chakravartty himself explores the virtues of art as a form of inquiry in the final chapter of his *Metaphysics for Scientific Realism* (2007). Van Fraassen clearly identifies secularism as insisting upon the sufficiency of science alone, and explicitly distances himself from any such claim (2002, 193), going on to explore the relationship between science and religion in the later chapters of that same work. It seems, then, that both the metaphysical and the empirical stances can accommodate the pluralism of inquiry required by science itself. And major proponents of each of those positions explore worlds beyond science; they do not merely pay lip service to other forms of inquiry.

§5.3 Towards a critical stance

Metaphysics and empiricism both circumnavigated the rocks on which the barque of scientism foundered. However, there are other dangers lurking beneath the surface of these waters. The metaphysical stance and the empirical stance oppose one another on the issue of explaining the observable by the unobservable. Metaphysicians, of course, accept the call for such explanations (M1) and offer them based on what science tells us exists (M2). Empiricists deny the call for any such explanation (E1) and all attempts to respond to it (E2). These two axes, the criteria of explanation and the line between observables and unobservables, are both contentious issues of course, but let us see what illumination of them we may find in Cassirer's work.

Cassirer's arguments against abstraction demonstrate that a mind-independent world is an untenable supposition, and conclude that we must interpret nature, the coherence of the world of experience, as a cognitive task to be achieved. That task is carried out by the symbolic forms, each of which creates a coherent world after its own fashion. Science carries out the task through measurement and lawful agreement of phenomena. Those phenomena, as we have seen, are (at least at first) the "common-sense" objects of the linguistic world, which, like science, is just another symbolic form that functions to unify the world of experience.

This elucidation raises questions about the division between the observable and the unobservable, upon which we draw to define the metaphysical and empirical stances: is that division (1) between the linguistic world and the scientific world, or (2) between the world of experience and the world in itself? In the first case, the linguistic world cannot serve as the solid epistemological bedrock standing as the foundation for science, because they both partake of the same foundation. Each is a symbolic form, and each draws its justification from its phenomenological place in the totality of symbolic forms. Neither is more solid than the other. Each draws its justification from the totality of which both are parts. Each of the symbolic forms leans on the others in order to find support. None of them can be established as the basis of the others, and therefore using the "observables" of the linguistic world as the fundamental support underlying and justifying the "unobservables" of the scientific world must fail. Our epistemological assurances about the observable linguistic world are partially drawn from the unobservable scientific world, and therefore cannot serve as a foundation for the latter. The two are codependent.

In the second case, where the observable/unobservable distinction maps onto the gap between the world of experience mediated through the symbolic forms and the world in itself, Cassirer will again claim that any kind of scientific explanation is bound to fail. Following Kant, Cassirer identifies science as a tool for synthesizing the coherent world of experience, and therefore rejects the possibility of applying science beyond the boundaries of any experience whatsoever. So what is beyond experience? Put succinctly, "the doctrine of the 'supersensible substrate' of nature and freedom is not about a primal *thing*, but about the primal *function* of the *spiritual*" (Cassirer 1918, 332). Scientific explanation serves only to unify experience, not to take us beyond it to a *Jenseitswelt*.

This distinction between observable and unobservable is really the heart of the problem for the metaphysical and empirical stances. In short, any talk of "things underlying the observable" or of "unobservables" is going to implicate a mind-independent world, which as we've seen is a supposition that comes under heavy fire from Cassirer's arguments against abstraction, as discussed above in §4.7.

Why is this a problem for empiricists? Empiricists, recall, explicitly espouse the methods of inquiry of the natural sciences (E3). Starting from the methods of the sciences, and specifically from the act of measurement, Cassirer shows that a mind-independent world is an unjustified postulation. So the tension in the empirical stance will arise because E3 undermines the supposition that there is some *thing* underlying the phenomena, that there is anything *unobservable*.

How might an empiricist might respond: "I don't believe in a mind-independent world, nor do I deny that there is one. I'm agnostic on the matter." But this response will not resolve the tension. Why not? In short, empiricism is the constant revolt against metaphysical speculation, but as presently formulated, it contains within it a metaphysical supposition about observability: not about what is or is not observable (which might be a scientific matter), or even about there being *anything* that is unobservable; but rather about what it *means* for something to be observable (which is a philosophical matter underpinning the science of observation). The problems for the empirical stance stem directly from their appreciation for the methods of the sciences, and from their revolt against metaphysics. These two features are in tension with their implicit acceptance of what it means to be observable.

Why would this issue be a problem for realists? Like in the case of the empirical stance, we'll want to find a tension that is internal to the metaphysical stance, rather than imposing the issue from the outside. Again, just as above, the problem arises because an examination of the act of measurement undermines the supposition of a mind-independent world. Whereas the empiricist had the avenue open to claim agnosticism about things underlying the phenomena (which ultimately isn't even successful), the realist endorses that there are things underlying the phenomena. They accept that there are "things underlying the observable," whereas an analysis of scientific activity itself showed that any such postulate would be unwarranted. Science itself implicates idealizations and holism (again, see §4.7), which infuses the entire scientific system with input from the mind, precluding any room for the supposition of mind-independence to come from within science itself.

The kinds of explanations that we find in science, be they lawful deductions or causal tracings, explain one thing in terms of another thing (where "thing" has an appropriately broad definition). To use Cassirer's language, in science we explain one series member by another series member. By contrast, we do not explain the world of experience by appealing to another world of experience behind it; we explain the world of experience by appealing to the underlying series form, its *function*.

In light of these clarifications of the notions of explanation and of the observable/unobservable distinction, we can now present a revised understanding of the empirical and metaphysical stances. We can rightfully ask for an explanation of any phenomenon within experience, and the appropriate explanation will be scientific or mythic or artistic, or of whatever kind befits the phenomenon in question. These questions are simply about how one particular symbolized phenomenon fits into its symbolic form. Let us call this "symbolic explanation," the explanation of any series member by another series member through their connecting series form, i.e.: the explanation of any phenomenon by situating it within its relevant symbolic form. But when we start asking about symbolic forms as a whole, symbolic explanation will not be appropriate. Series forms lie on a different plane than series members, and so explanations for series forms must take another shape.

For a symbolic form as whole, we may rightfully request two kinds of explanation: transcendental explanation and dialectical explanation. Transcendental explanation offers the conditions of possibility for a symbolic form, outlining how it is that the symbolic form in question constructs a coherent world of experience, which is the goal towards which all symbolic forms must strive. These explanations draw on the transcendental method, the strong Kantian heritage evident everywhere in Cassirer's work. It is his adherence to this method that truly marks him as an intellectual descendent of the great critic of reason, as a member of the Neokantian tradition.[6] It is this type of explanation that Cassirer offered for science, language, and myth in *Substance and Function*, *Philosophy of Symbolic Forms vol. 1: Language*, and *Philosophy of Symbolic Forms vol. 2: Mythic Thought*, respectively.[7]

Dialectical explanation, inspired by Hegel and drawing on the phenomenological method, outlines how a given symbolic form is justified. These explanations are historical, temporally situated, showing how a particular symbolic form, a mode of cognition, emerges in response to demands emanating from prior forms. It is the demands that justify individual forms, both the form from which the demands emanate and the form that fulfills those demands. Kant's analysis of science applied the transcendental method to one particular state of science, which he had assumed would remain stable. It was the course of scientific revolution itself that overthrew this supposition, and it was to science in transition that Cassirer applied the transcendental method. He inquired into how scientific revolution was possible. But the application of the dialectical method does different work here, elucidating not how transitions are possible, but rather how they are justified.

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[6] For more on Cassirer's adherence to Kant's transcendental method as opposed to the system that Kant constructed through the application of that method, see (PSF I, 22; PSF III, 7–10; Hamburg 1949, 91; Swabey 1949, 123; Stephens 1949, 153; Werkmeister 1949, 794–795; Krois 1987, 114–120; Verene 2001, 10–17; Ikonen 2011, 200).

[7] For more details on how Cassirer's works are divided into different projects along the lines discussed here, see §4.1 above.

I contend that these clarifications of explanation and of the observable/unobservable distinction entail important consequences for the empirical and metaphysical stances, in light of the difficulties intrinsic to each one as detailed above. Specifically, I suggest that these two stances are important complements to one another, and that once we understand how the two limit each other, they jointly point in the direction of what I will call the "critical stance."[8]

M1 states that we should "accept demands for explanations in terms of things underlying the observable." In light of Cassirer's clarifications, we can specify that requests for the explanation of particular phenomena, symbolic explanations, can rightly draw on "things underlying the phenomena." Underlying the phenomena we find a symbolic form, not another series member of that form. Accordingly, I propose the first element of the critical stance:

C1 – Accept demands for symbolic explanations of phenomena, drawing on the relevant symbolic form to explain one symbolized phenomenon by another.

But this is not an unqualified adoption of the metaphysical stance over the empirical stance,[9] for empiricists are right to impose constraints on these demands for explanation. E1 states that we should "reject demands for explanation in terms of things underlying the phenomena." In response to this call for constraint, I offer the second element of the critical stance:

C2 – Reject demands for the symbolic explanation of symbolic forms. Instead, symbolic forms can be explained using the transcendental and dialectical methods, which elucidate the conditions of their possibility and their justification, respectively.

And finally, to address the primacy of science:

C3 – Take science as the best model of the interpenetration of the form of inquiry and its content (not because science is ontologically or methodologically privileged, but because its exemplification of the significative function most clearly discloses to us the co-constitutive relationship between the world and experiencing subjects).

I see the critical stance not as the negation of the metaphysical or empirical stances, but as their interpenetration. The two are preserved in their tension, in their mutual limitation expressed through the critical stance.

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[8] The tension pointed out above suggests that we need to reinterpret the empirical and metaphysical stances; what I'm proposing as a reinterpretation here draws on Cassirer's positive project to direct those reinterpretations. Thus, while I think that Cassirer's negative arguments, against mind-independence, do indeed put the onus on empiricists and realists to tend to their stances, I acknowledge that what follows does *not* offer an argument that the reinterpretations *must* proceed in the fashion I suggest. Rather, I'm presenting merely a sketch of how I see that process playing out if Cassirer's positive arguments are also followed.

[9] For those who find the opposition of empiricism and metaphysics strange, perhaps suspecting that empiricism is itself a metaphysical position, please recall that empiricism *as a doctrine* is indeed a metaphysical position, and therefore teetering dangerously on the precipice of incoherence. In fact, it is that very concern that led van Fraassen to elaborate the language of doctrines and stances, so that as a stance empiricism could avoid falling into that yawning pit. For more on this, see §1.4 above.

With the critical stance now in hand, let's take another pass at those arguments against the empirical and metaphysical stances, in case the first formulations were unclear. Empiricism is characterized by its perpetual struggle against metaphysical speculation (van Fraassen 2002, 45), but also maintains that "truth and error are objective categories, handed to us by nature itself" (van Fraassen 2002, 87). What is this claim other than a metaphysical speculation? Cassirer's arguments against abstraction show that the practice of science itself, which is the acknowledged guiding light of empiricism (van Fraassen 2002, 63), discloses to us the role of the experiencing subject in constituting the world of experience. Science itself calls for a reinterpretation of truth and objectivity as tasks for cognition, tasks that science can only partially fulfill. Thus empiricism is shown to be internally inconsistent as presently formulated. Its notion of objectivity must be renounced under the heading of metaphysical abstinence; but its replacement by the critical notion of objectivity requires speculating beyond the limits of the observable. Objectivity as the task of unifying experience fulfills the empiricist's dream, seeking to avoid speculation about the *things* beyond experience, and instead elucidating the function of objectivity, based on the practices of science.

Metaphysics is characterized by its desire to explain experience by that which lies beyond, specifically in this case using the content of science as the guiding light for that speculation. But the notion that beyond the world of experience lies another world, of which experience is but a copy (and often a flawed copy, at that), is undermined by the practices of science itself. Measurement and unification according to law are incompatible with the abstraction theory of concept formation and ultimately with mind-independence; they require that objectivity be understood as an infinite task rather than a mere copy. We can indeed speculate about what lies beyond experience, and use science to do so, but cannot presuppose that what lies beyond is another substantial world. Cassirer's arguments thus demonstrate that what underlies experience is the conditions of possibility for experience: not a substantial object but a spiritual world-building function. Thus, the metaphysical stance too is internally inconsistent, and in recasting the stance to rectify the problematic sense of what underlies the phenomena, we once again arrive at the critical stance.

In §3, we explored the problems with abstractionism, and how they undermine the mind-independence of the world, the supposition on which the whole realist–empiricist debate is constructed. Each doctrine in that debate begins from a faulty premise. Recognizing the fault, those doctrines became untenable, announcing the need to retrench. In §4, we laid out Cassirer's alternative to these doctrines, his philosophy of symbolic forms.

At the outset of the present chapter, we explored how one goes about retrenching, specifically by going back to one's stance with doctrinal concerns in hand, and producing a fresh interpretation based on an underlying, guiding spirit, the set of belief-generating policies. Given that the realist and empiricist doctrines were imperiled by the anti-abstraction arguments, we explored their underlying stances, to see whether and how they could retrench. The scientistic stance was shown to be irrecoverable, because the practice of science requires dialectical, phenomenological grounding that comes from outside

science itself. The metaphysical and empirical stances were also shown to exhibit some internal tensions, but were not damned to the same fate as scientism. Rather, metaphysics and empiricism simply needed a slight re-orientation in order to iron out some of their rather unsightly creases. My suggested route for ironing out those creases in fact leveled off the differences between empiricism and metaphysics, maintaining that the two converge on a position I've called the critical stance.

The critical stance is not immune to revision. Nor is Cassirer's doctrine of the symbolic forms, which flows from his application of the critical stance, though he himself never presented the project in such terms. Cassirer emphasized time and again that his symbolic forms project was not a system, but rather a systematic review.[10] The symbolic forms project is never finished, but requires constant revision, fresh interpretation perpetually flowing from the critical stance. Cassirer points out that for Kant there was no separation between his method and the results that he derived using that method (Cassirer 1918, 366), and I believe that the same is true of Cassirer himself.

The application of the stance will always bring out new features in the doctrine, and problems cropping up with the doctrine will always in turn refresh and deepen our understanding of the stance. We should not be surprised by this, as experience itself is never finished, an unending task. And now we must bring the present chapter to an end, and move on to the conclusion of what has felt to me (at times) like a never-finished, unending task, but one that has brought me immense satisfaction and intellectual edification. I hope that you have not too often, in reading this dissertation, yearned for the task to end.

[10] For instance, (Cassirer 1950, 19).

CONCLUSION

At the very outset of this project, I spoke of the ongoing and bitter struggle between realists and empiricists. Hopefully the foregoing, the symbolic forms project and the critical stance, will prove itself to have been the negotiation of a successful peace. This uneasy treaty, recall, has been written only to silence the muskets of realist–empiricist skirmishes in the scientific theatre, and I urge that the pattern be followed in drawing up further accords in other areas where analogous wars rage.

The prevalent view of the subject–world relationship, as I mentioned in the introduction, has bred an overarching atmosphere in our time of scientism and cultural relativism, a belief that natural science reigns in the realm of objective facts whereas the territories beyond (e.g.: ethics, art, religion, culture, etc.) are the provinces of mere opinion, subjective belief. In science there are right answers, full stop; beyond, there are only opinions, right answers for you and right answers for me, and no need for rational discourse between us because there is no fact of the matter on which to settle.

Through Cassirer's work, I hope to have dismantled one horn of this two-pronged attack. The criticisms of abstraction theory, mind-independence and epistemological foundationalism have, hopefully, demonstrated that the objectivity we attach to science needs to be reinterpreted as a task for cognition. There are definitely right and wrong answers in science, but it does not have a unique and exhaustive claim to objectivity, science being only one form among many that fulfills the world-building function. It is only one method among others, and the method that we adopt in order to answer a given question must befit the question itself. How we address scientific questions has been discussed at length above (§3), and must be contextualized by the symbolic forms project as a whole (§4) and the critical stance (§5) from which the symbolic forms project flows.

What is lacking here is a discussion of the methodology of the cultural sciences. More information on that subject can be found in Cassirer's work *The Logic of the Cultural Sciences*. I am also putting together some thoughts on Cassirer's philosophy of history, specifically bringing his ideas into discussion with those of Charles Taylor, as alluded to in the introduction. Just as this dissertation has used discussions of science to provide a model for dissolving realist–empiricist disputes in other areas, so too do I hope that my future work in the philosophy of history will provide a model for the notion of objectivity that reigns in other cultural sciences. These two parts form a couplet and should be read as complementing one another, aiming to ventilate the naturalist air that constitutes our present atmosphere. My hope is that these efforts will contribute to a deepening of the general understanding of science and culture, their methods, limits and interrelations, and ultimately help us to better understand ourselves and one another.

And what role does philosophy have to play in this endeavour? Many commentators on Cassirer's work point out its conspicuous absence from the symbolic forms project. Is philosophy another symbolic form alongside the others? If so, its claim to objectivity seems just as situated and relative as the claims of science, language and myth. If

philosophy is not a symbolic form, does this erode the completeness of the symbolic forms project, undermining Cassirer's intention? Some see this dichotomy as exhaustive and damning, but I believe such a judgment to be overhasty. I will not give a full-length argument here so much as sketch a response.

First off, let us acknowledge that philosophy is indeed historically situated, not a pure and timeless inquiry. Cassirer acknowledges as much in his trilogy tracing the emergence of the modern philosophical spirit, *Individual and the Cosmos in Renaissance Philosophy*, *The Platonic Renaissance in England*, and *Philosophy of the Enlightenment*. Let us also recall that for Cassirer, there is no antithesis between being historically situated and being objective. Science is for Cassirer the emblematic model of objectivity, and he takes great pains to show that its grounding is phenomenological, emerging dialectically from its history. The objectivity of philosophy is therefore no more threatened by its historicity than is the objectivity of science, nor need its perpetual incompleteness cause us any worry. The model of complete and ahistorical objectivity is simply a relic of a naturalistic way of thinking, and so philosophy has nothing to fear in falling short of this relinquished standard.

However, in spite of its historicity, philosophy is not a symbolic form. Once again, we come back to the relationship between series forms and series members as a helpful analogy: philosophy is the series form; the symbolic forms of science, language, myth, etc., are series members. Philosophy situates the symbolic forms. And as we have seen in many different contexts in this dissertation, the series members have no meaning except through their series form, and the form has no purpose but to delineate those members. The different natural and cultural sciences study the world, each creating a world according to its own standard. By contrast, the object of study for philosophy is not those worlds, but those world-shaping powers, the *function*, the natural and cultural sciences themselves. Philosophy is an arbitrator between different forms of cognition, aiming to maintain an appropriate balance between them. Philosophy is the watchman of culture, and must warn us of dangerous imbalance.

And so, one might well ask: are series form and series member sealed off from one another in our present world, especially in the academic sphere? Have we institutionalized one-sidedness, entrenching one-sided metaphysics in our very practice? Are the structures of present-day academic philosophy conducive to the role as analyst of and mediator between intellectual fields? And has philosophy lost touch with the public sphere? If philosophy is the watchman of culture, has our ivory watchtower been built so high that we can no longer survey the land sprawled before us, and has our alarm bell been rendered inaudible from below?

Cassirer delineated two conceptions of philosophy (1979, 58–9): the scholastic and the worldly. The scholastic form strives towards the "logical perfection of knowledge and the systematic unity of knowing," whereas the worldly explores the relations amongst forms of knowledge and practical ends. Has philosophy been reduced to the "delight in puzzle-solving," as van Fraassen worries (2002, 17)? Is present-day philosophy open to the criticism Cassirer leveled at *l'art pour l'art*, which he termed "an enigma for the vulgar,

chamber-music for the initiated" (1979, 201–203)? Are we nothing more than masters of the glass bead game?

These are important questions on which we must reflect, lest the form of philosophy undermine its function. Social discourse is growing more and more polarized, more partisan, and the need for intellectual mediation in the public sphere grows desperate. If Cassirer is right that this is the function appropriately fulfilled by philosophy, then we are called upon to ensure that our professional structures facilitate our working towards such ends. Are the structures of the academic sphere conducive to a balance between the scholastic and the worldly forms of philosophy? I fear that our academic duties are entirely discharged through scholastic pursuits; and our social duties: gravely neglected. To these I must turn my attention presently.

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APPENDIX Ψ

How should Heisenberg's uncertainty principle impact our understanding of fundamental reality? There is a long and colourful historical narrative in which scientists have tried to answer that question, both theoretically and experimentally. These are the milestones in that discussion, as I've come to understand it. These papers are often (though not always!) technical and difficult, but very rewarding. The discussion really begins with (Einstein, Podolsky and Rosen 1935), and the response from Bohr (1935). Bell's theorem, and Bohm's interpretation thereof, are the next volleys, appearing in the 1960s. Alain Aspect then developed and ran an experimental version of Bohm's interpretation of Bell, see (Aspect 1982, "Experimental Test of Bell's Inequalities Using Time-Varying Analyzers"). Until that point, theoretical and experimental moves in the discussion had all focused on 2-particle situations. Greenberger, Horne and Zeilinger introduced something new into the discussion, by including considerations from 3-particle systems (see GHZ 1989, "Going Beyond Bell's Theorem"). They then tested these hypotheses experimentally (see Zeilinger 2000, "Experimental test of quantum nonlocality in three-photon GHZ entanglement"). A further step is Scully's "quantum eraser," where the results of experiments are clearly influenced by the questions we're asking, specifically about whether we're asking wave-relevant or particle-relevant questions. By far the most astounding result here, for me, is that this influence has its effect regardless of *when* we ask our questions, before or after the experiment! See (Scully 1982, "Quantum Eraser;" 1999, "Quantum Erasure;" and especially the accessible digest of this issue in *Scientific American*, 1994, "The Duality in Matter and Light").

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