

Does Science License Metaphysics?

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Abstract

Naturalized metaphysicians defend the thesis that science licenses metaphysics, such that only metaphysical results that are based on the best science are to be considered legitimate. This view is problematic, due to the fact that the reasons they identify for such license are apparently self-defeating. Chakravartty (2013) defends a revised approach to understanding the licensing relation. I argue that the proposed response is a step forward on behalf of naturalizing metaphysics, but still does not take seriously the contention that science involves, inextricably, a contribution from the a priori. I conclude by considering what options the aspiring naturalized metaphysician is left with.

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Introduction

No doubt philosophers have seen the results of science as relevant to forming and revising metaphysical theses. Darwinism, Relativity, and the Quantum Theory (among others) have all been invoked in metaphysical debates about the the nature of necessity, the reality of future events, and the status of objects, to name only a few (see for examples of each: Dewey (1910); Putnam (1967); and Bohm (1980), respectively). This sort of theorizing often proceeds without much thought to the question of whether, and in virtue of what, science delivers metaphysical knowledge. In the above-mentioned cases, there is a presumption that scientific theories are important and relevant for generating metaphysical knowledge. Whether and how this presumption is justified is often unquestioned.

It is only relatively recently that there has been focused attention on this latter (meta-)question of science's suitability and applicability to metaphysics (see for examples Chakravartty (2007); Ladyman (2007); Ladyman and Ross (2007); Maudlin (2007); Ney (2012); Paul (2012); Ross et al. (2013)). While the historical causes of this increase in a distinctively self-conscious investigation of the relation between science and metaphysics are themselves interesting (for some suggestions as to its etiology see Ney (2012)), the concern of this paper is with the plausibility and potential success of arguments intended to answer the question: "Does Science License Metaphysics?" The naturalized metaphysician is one who answers in the affirmative, aiming to conclude that science is the (only) source of, and license for, genuine metaphysical theorizing.

Given the variety of contributions to this debate it is difficult to justify

just one of the authors mentioned above as encapsulating the views of ‘Naturalized Metaphysics’ generally. There is, however, a dialectic that each author must engage with and Chakravartty (2013) provides a paradigm example of the naturalist doing so. For the purposes of this paper, I will presume that Chakravartty gets the outlines of a naturalized metaphysics correct in its broad details. If we accept this presumption, we then face a further question about the success of Chakravartty’s account of justifying naturalized metaphysics. Chakravartty identifies a fundamental difficulty in providing such a justification while adhering to naturalistic scruples, and he outlines a path to steer clear of this difficulty while preserving the naturalist spirit. While there is much to learn from Chakravartty’s response, I argue that it ultimately fails to take seriously the problems facing any attempt to locate the source of metaphysical authority in the empirical or a posteriori content of science.

After reviewing the general contours of the debate in the first section, in Section 2 I explore Chakravartty’s proposed response to the argument that metaphysics cannot be naturalized. In Section 3 I argue that while the proposed response is a step forward on behalf of naturalizing metaphysics, it still does not take seriously the contention that science involves, inextricably, a contribution from the a priori. I conclude by considering what options remain for the naturalized metaphysician.

1 Science and Metaphysics

The motivation for a naturalized metaphysics has its source in the sorts of projects mentioned at the beginning of this paper. For example, Putnam

(1967) argues that special relativity has important implications regarding the reality of temporally distant objects, and thus has important implications for our metaphysical theories about the nature of time. There is, the naturalized metaphysician insists, a very plain sense in which scientific discoveries influence what sort of metaphysical theories we take seriously—perhaps even claiming that such theories (such as Putnam’s case with SR) can play the role of deciding which metaphysical theory should be accepted, or at least which we can reject. This sort of presumption is widespread—consider for example the prevalence of Eddington’s (1955) ‘second table’ in our everyday explanations about what commonsense objects are *really* like.

Granting this *prima facie* connection between the deliverances of science and metaphysical speculation, how are we to distinguish the naturalized metaphysician from the analytic (non-naturalized) metaphysician? In answering this question the naturalized metaphysician wishes to achieve two desiderata. First, they need to indicate what distinguishes their preferred approach from analytic metaphysics. Second, whatever this difference is, it must constitute the reason that naturalized metaphysics is a better guide than analytic metaphysics to metaphysical truth. Chakravartty identifies the difference as one of methodology:

The distinction between putatively acceptable naturalistic metaphysics and putatively excessive metaphysical inquiry does *not* concern *what* these forms of inquiry aim to do... [r]ather it concerns *how* these forms of philosophical inquiry go about achieving these aims. It is not in terms of general goals but rather in terms of precise methods that the distinction between naturalized metaphysics

and some other brands of ostensibly worrying analytic metaphysics must be drawn. (Chakravartty 2013, 32)

Since their ultimate aim is shared in common, the disagreement must be one about the means to achieve it. The suggestion of the naturalized metaphysician is that, since science is our best model of inquiry, we should look to science alone as a guide for achieving our aim. The difference between this view and the analytic metaphysician's is then a disagreement about which model of inquiry carries with it the authority to license metaphysical inferences.

What about the preference for a scientific model of inquiry supplies the reason for naturalized metaphysics' superiority in the eyes of the naturalist? Chakravartty puts it as follows:

[Analytic metaphysics] proceeds by way of a priori stipulation and theorizing, and produces claims that are *empirically untestable*. . . naturalized metaphysics, in virtue of its scientific starting point and context, is conceived as being *susceptible and sensitive to empirical concerns*. (Chakravartty 2013, 32–33 emphases added)

For Chakravartty's naturalist it is 'the empirical' and the differential role it plays with respect to naturalized and analytic metaphysics that marks out the former's legitimacy. Any metaphysical knowledge worth having is the sort of knowledge that is (in principle) defeasible in light of new, empirical, information. The sort of knowledge claims analytic metaphysics licenses are, on the contrary, "too far removed from the details of scientific investigation to yield anything worth having at all. . . [it] is epistemically impotent, and thus a misguided philosophical pursuit." (Chakravartty 2013, 29)

Care is required in articulating the details of a naturalized metaphysics as just specified. Note that the naturalist claims that it is *science* to which the metaphysician must look and against which they must measure their theories. But in providing a reason for the superiority of science as a licensing authority, Chakravartty's naturalist explicitly singles out the role of *the empirical* as constituting that reason. However, this picture of naturalized metaphysics only works if we allow 'the empirical' and 'the scientific' to be conflated. And, Chakravartty admits, "there is a certain caricature of the sciences on which this conflation is benign." (Chakravartty 2013, 33) Science is often treated as a purely empirical enterprise, where observations are collected, patterns are deduced from the observations, and theories are constructed *sui generis* from these patterns.

Such a caricature, however, fails to take seriously important aspects of scientific practice that complicate the naïve view of science as a simple empirical enterprise. And significant work in the philosophy of science of the past century undermines the plausibility of the idea that there is such a thing as pure, a posteriori methodology within the sciences.

The naïve view of science presupposes an easy and unproblematic distinction between observation and theory, so that theories are derived purely from empirical observations, which themselves have no a priori antecedents. But we have good reasons to reject such a presupposition. Kuhn famously argues that scientists working in periods of normal science already accept a priori metaphysical assumptions as part of the paradigm to which they belong. And, as Chakravartty points out, Kuhn's is one of many accounts that articulate "the cognitive preconditions of scientific work. . . that function to establish the very

categories of objects, evidence, and inference that allow scientific questions to be posed and then investigated.” (Chakravartty 2013, 35)

To pick just two examples of recent work in this area, Michael Friedman (2001) and Hasok Chang (2004; 2008) both highlight the role of constitutive principles (sometimes referred to as ‘the constitutive a priori’) in the construction of ‘frameworks’ within which observations are made possible. Consider one of Chang’s examples: the possibility of making an empirical measurement of temperature presupposes what Chang calls the *principle of single value*—that physical properties cannot have more than one value in a given instance. This is not an empirical claim: it is not a generalization from experience, nor could experience alone act to provide a counterexample of it (cf. Chang 2008, 123 ff.). Yet, it plays a central role for scientists who wish to develop the concept of temperature.

We should see immediately that the presence of a priori principles in science appears to undermine completely the naturalization of metaphysics as suggested above. For once a priori principles are present in science a problem arises—how are we supposed to adjudicate disagreements between scientists about which a priori principle is better justified, or how to interpret any given principle? Such disagreements are immune to resolution on purely empirical grounds, and instead must rely, (at least in part) upon conceptual analysis and the trading of a priori intuitions and reasons. And *this* activity is precisely the sort of thing the naturalist wishes to rule out by naturalizing metaphysics in the first place! It appears that naturalized metaphysics is faced with a charge of self-refutation—in eschewing a priori reasoning as a legitimate source of metaphysical theorizing, and by re-locating metaphysical legitimacy to the domain

of science, the necessity of reasoning about a priori principles is reasserted.

2 The A Priori Contribution to Science

There are, however, several responses available to the aspiring naturalist faced with the purported incoherence of their project. One might simply retrench, denying that there are in fact any a priori principles operative within science, and reassert the picture of science in which observations are unproblematically free of theory, and completely determine whichever theory is to be derived from them. But while open in principle, this path is unattractive for many reasons, not least of which are the considerations Chakravartty explicitly invokes when he acknowledges Kant, Kuhn, Friedman and others (cf. Chakravartty 2013, 34–36).

Chakravartty, instead, pursues a second response. Even if we admit that a priori principles are present in science, there is still a clear sense in which empirical considerations play a role in *scientific* experimentation and theorizing which they do not play in *speculative* metaphysical theorizing. Chakravartty proposes that we focus on this difference:

Granting that scientific knowledge has a priori dimensions, it remains the case that the forms of inquiry we collect under the banner of the sciences are *permeated with a posteriori content in virtue of the empirical concepts* with which they are concerned. So why not take ‘naturalized metaphysics’ to label those metaphysical projects that are derived from, based on, inspired by, motivated by, constrained by, and grounded in *this specifically empirical content*,

as opposed to scientific knowledge more generally? (Chakravartty 2013, 42 emphases added)

The strategy is to simply work our way through science piecemeal, examining it part by part, and partitioning out the *specifically empirical content* from those parts that are infected with a priori principles. It is this empirical content that will serve as the basis for naturalized metaphysical projects.¹ Even this response is not wholly satisfactory for Chakravartty however:

[T]he criterion of legitimacy suggested is far too easy to fulfil. Indeed, there is good reason to think that it is generally trivially satisfied, which would entail that every metaphysical project is an instance of naturalized metaphysics. (Chakravartty 2013, 42)

Chakravartty proceeds to give an example of how, on the basis of this criterion, “Platonism [can be] derived from experience,” and so would count, on this view, as properly naturalized (cf. Chakravartty 2013, 42–43).

Ultimately, Chakravartty sees that the purely empirical content of science, as such, is too weak to constrain metaphysics in any meaningful way. This is just to say that even the most speculative metaphysical theories (such as Platonism) are empirically adequate! The sort of metaphysical theories that such a principle would bar are theories that no one could take seriously, since they would fail to recover the appearances they were initially mobilized to explain. Even Parmenidean monism must explain why it *seems* as if things

¹Anyone familiar with Quine will notice the tension between Chakravartty’s proposal and Quine’s suggestion that “the unit of empirical significance is the whole of science.” (Quine 1951) In the next section I’ll consider what picture of science Chakravartty has committed himself to.

change.

If all metaphysical theories have a ‘connection’ to the empirical content of science, we must seek to articulate the superiority of naturalized metaphysical theories according to a different criterion. Chakravartty suggests that the naturalist return to the idea that legitimate metaphysical theorizing possesses a “proximity to the scientific context.” (Chakravartty 2013, 33) In other words there are “cases in which, though it may never be possible to carry out an empirical test—for example, to establish the one-way speed of light, or to detect the presence of hidden variables in quantum mechanics—it is nevertheless possible to understand what may be regarded as a priori commitments as *appropriately linked to a posteriori content.*” (Chakravartty 2013, 43 emphasis added)

Metaphysical commitments to such things as the one-way speed of light have a proximity to empirical content that commitments to things such as universals simply lack. If we can make clear the nature of this connection, then we might have a defensible formulation of naturalized metaphysics. Chakravartty suggests the following two (not necessarily exhaustive) parameters for making sense of this notion of proximity: ‘experiential distance’ and ‘risk’. Experiential distance, he explains “concerns that manner in which [the object of inquiry] is detected, if in fact it is detectable at all”:

Tyson, the barking dog across the street in our otherwise quiet neighborhood, is directly detectable by me using my unaided senses. Proteins are less directly detectable; I would need to take a sample from Tyson and perform an assay in the lab to detect them. The possible worlds in which I now demonstrate this procedure to my

friends and neighbours are not detectable at all. (Chakravartty 2013, 44-45)

Chakravartty's second parameter, 'risk', "concerns how susceptible a hypothesis or a theory is to disconfirmation in light of the results of empirical work." (Chakravartty 2013, 45) For example, the hypothesis that possible worlds are real—since few (if any) empirical considerations bear on its truth-value—is a low-risk hypothesis and thus further removed from the domain of empirical science than other, riskier hypotheses.

The task of a naturalized metaphysics, on this reformed view, is not to favor metaphysical hypotheses derivable from the empirical, since every metaphysical hypothesis can be so derived. Instead, its task is to articulate the particular kinds of relations in which hypotheses can stand to the empirical content of science and favor those which stand in acceptably 'close' relations to this empirical content.

Granting this revised picture of the task and subject matter of a naturalized metaphysics, there is an important corollary: The process of deciding the appropriate criteria by which to separate out legitimate metaphysics from its more speculative cousins—determining how experientially distant is too far, or how unrisky is too safe—will be open-textured and subject to considerable interpretation and argumentation. Note that nothing about the concept of experiential distance, even if it gave us a well-ordering of metaphysical theses arrayed from 'close' to 'distant', would conclusively tell us where to 'draw the line' between hypotheses sufficiently close, and those too distant.

3 Empirical Content and the A Priori

I agree with Chakravartty that it is important to recognize the implications of the radical underdetermination of the metaphysical by the empirical. Since even the most speculative metaphysics has as its explanandum phenomena arising from everyday experience, identifying naturalized metaphysics by the constraint that its speculation must merely agree with everyday experience is no real constraint at all. Additionally, he is right to give up the idea that there can be some objective demarcation criterion that rationally compels us to divide legitimate/naturalized metaphysics from illegitimate/non-naturalized metaphysics. How speculative one may permit their metaphysics to become is not purely a matter of logic and reflects other commitments as well.

However, the solution Chakravartty proposes does nothing to avoid the fundamental difficulty that the naturalist is faced with. Recall that what caused trouble for the naïve picture of naturalized metaphysics was the reliance on a caricatured view of science that failed to account for the a priori principles that are at work in scientific practice. Chakravartty's proposed solution inherits an unjustified assumption from this naïve caricature of science. Whatever plausibility the naïve view has, it possesses on the basis of two assumptions: first, that there is a clear distinction between theory and observation; and second, that there exists something called 'empirical content' which is present in the act of observation, and is theory-neutral and available to all observers.

While Chakravartty clearly rejects the first assumption when he highlights the role of a priori principles in science (cf. Chakravartty 2013, 34-36 and see §1 above), by suggesting that naturalized metaphysics can be cashed out in terms

of measuring the relation of theoretical claims to the “specifically empirical content” of science, he tacitly endorses the second assumption. But, we should reject this second assumption for the same reasons that we rejected the first: the a priori principles present in science are not justified by experience, and instead are presupposed to give experience content in the first place.

In order to make explicit the role this latter assumption plays (and the problem it poses) for Chakravartty’s proposed account of naturalized metaphysics, let us consider one of his favored parameters: experiential distance. In general, entities ‘closer’ to experience are supposed to have a stronger claim to being legitimate objects of metaphysical inquiry than those more distant. But how are we supposed to determine how close an entity is, or the relative ordering of various entities? Chakravartty’s examples give us little by way of guidance in any but the easiest cases. The manner in which I detect a dog versus a protein are clearly different—dogs are macroscopic objects which can be observed by one or more of our sensory modalities; proteins are microscopic objects whose presence is only indicated through a chain of inferential steps.

But of course differentiating between dogs and proteins is not of great interest to the naturalized metaphysician. How might we determine the relative proximity to the empirical of more difficult cases, like between (say) an electron and its electric charge? Perhaps this is an easy case—“clearly electrons are closer to experience, since they are objects, whereas electric charge is a property, and thus more abstract.” But a similar case can be made for the converse, since properties are what are directly detected, not the object itself. Adjudicating *this* disagreement cannot proceed solely by way of examining the experimental apparatus again, because this disagreement is one about the

ontological status of objects versus properties, not about whether we see (for example) a trace in the cloud chamber. Only after settling the question of which is more directly detectable (substances or properties?) can we agree on the *empirical content* of our experience. In order to apply Chakravartty's parameter of experiential distance to theoretical entities, we require that there is some empirical content in our experience which is stable and against which we can do the measuring. However, the empirical content of experience is itself theory-laden. Two people with different theories will see different empirical content in the same data.

To highlight this point, consider another example: N.R. Hanson's 'Kepler and Tycho'² (1958, 5 ff.) arguing over whether the sun moves or is stationary. In one trivial sense they see the same thing. If we asked them to draw a picture of what they see as they watch the sun at dawn, their pictures would match. The image on their retinas is identical. Yet they *see* different things—their experience is different. Tycho has drawn a picture of the sun rising above the stationary horizon of earth. Kepler has drawn a picture—identical in its structure—of the the spinning earth rotating before the stationary sun. And this disagreement need not be restricted to the modality of sight. Both have no feeling of being in motion. Yet Tycho has the experience of being at absolute rest, while Kepler experiences uniform unaccelerated motion. What their experience is *of*, and the *significance* of that experience is preconditioned by the fact that Tycho accepts an Aristotelian metaphysical picture of motion which requires continuous impulse, while Kepler accepts the Galilean picture

²Hanson idiomatically refers to Johannes Kepler by last name and Tycho Brahe by his first. I will follow Hanson in this convention in order to make clear that these are Hanson's anachronistic characters, and not the historical persons.

of relative inertial frames.

These examples highlight the problem Chakravartty is faced with in proposing to determine the legitimacy of a piece of metaphysical theorizing by its proximity to ‘empirical content’: The empirical content of my experience *depends on* what scientific and metaphysical theories I accept, and those theories in turn cannot be determined by referencing some objective and theory-neutral content which all observers share. The disagreement between Hanson’s Kepler and Tycho about whether the universe is heliocentric or geocentric is not settled by observing the sunrise—for that experience holds different content for each. Coming to an agreement about what is the empirical content of our experience will require making recourse to a priori reasoning and the trading of intuitions. Kepler might succeed in convincing Tycho of the superiority of the heliocentric theory, but not by ostending to the horizon at dawn, just as Tycho will not succeed in convincing Kepler of the contrary by pointing to the fact they feel no apparent motion.

We can generalize these points by drawing a distinction between the data of an experiment, and the empirical content of that same experiment. It is correct to insist that the *data* of an experiment are shared between all competent observers (under standard conditions, etc.). But to insist then that the data completely determine the empirical content of the experiment is to invite back in the idea that observations stand free from the theories they confirm. The data never speak clearly for themselves—we require a theoretical framework in order to determine the significance of the data. If we admit this much, then insofar as there are a priori principles at work in our theories (as Chakravartty grants, again see §1 above), the empirical content of science cannot serve as

a theory-free background against which all metaphysical theories can be compared. Empirical content—the *significance* of the data—will be relative to metaphysical commitments already accepted.

The consequence of this point is that the charge of incoherence against the naturalized metaphysician remains. Recall above, naturalized metaphysics appeared incoherent since science did not rule out a priori principles and commitments but instead required them in the first place. Chakravartty suggested that the naturalized metaphysician escape this problem by judiciously avoiding those a priori principles wherever they appear in science, and picking out piecemeal the empirically significant parts of science, grounding our metaphysics on that. What I've argued for here is that a picture of science where such a piecemeal process is possible—where there is an unproblematic and objective partition in the parts of science which are infected with a priori commitments, and those which are not—is as much of a myth as the naïve picture of science Chakravartty saw fit to reject.

4 Prospects for a Naturalized Metaphysics

What responses remain open to the aspiring naturalized metaphysician? First, the naturalist could once again retrench, insisting that there is unambiguous empirical content, theory-neutral and given in experience. But as was remarked before, this position requires that one reject a significant portion of the widely accepted philosophy of science literature about theory-ladenness and underdetermination. Returning to this caricatured picture of science looks implausible as long as the naturalist insists that we should take science seri-

ously.

The second option is to admit defeat, and accept a place for analytic metaphysics in a general model of inquiry. Tethering metaphysics to the whole of science wasn't sufficient to escape the presence of a priori reasoning, and recourse to the 'empirical content' of science didn't escape the presence of antecedent metaphysical commitments. Perhaps the naturalist has no further responses, and must let a priori metaphysics in.

Chakravartty, and the aspiring naturalist appear to be caught in a dilemma. On one hand, if one wishes to preserve a metaphysics grounded in the pure a posteriori—a metaphysics free of any a priori principles, and informed solely by what bare experience 'tells us'—then it appears as though we must commit ourselves to an implausible and unsophisticated caricature of science, one that does violence to more nuanced accounts of scientific practice. On the other hand, if we wish to develop a naturalized metaphysics that accounts for the actual practice of science, it looks like we're forced to admit that scientists themselves have as many a priori metaphysical assumptions as other folk, and metaphysical conclusions based off such assumptions are just as subject to a priori critique as more speculative theories of analytic metaphysicians.

However there is, I think, a third option that allows us to escape the dilemma, albeit at a (modest) cost to the naturalist. My argument about the antecedent role of a priori principles in science shows only that what counts as the empirical content of an experiment will always be relativized to whatever theory is a priori accepted. The anxiety about a priori intuitions playing a role in determining these theories assumes that the task of metaphysics is to discover reasons and evidence for identifying one metaphysical theory as true,

at the expense of its competitors. If this is the case—if any metaphysics worth doing is metaphysics that must eventually settle on a single correct theory—then perhaps the anxiety is justified. But I see no reason why the naturalized metaphysician must accept this assumption.

Instead, why not accept that the empirical content, and thus the content which can ground interesting metaphysical theorizing, will be relative to the theories already accepted, and leave it at that? For surely there are other ways of determining which theory we should both accept, besides a priori demonstrations that one is rationally unacceptable, and the other rationally compulsory. Pragmatic reasons can be mobilized to convince those with different a priori principles of the attractiveness of one's own position. Recall Chang's (2008) principle of single value—we aren't compelled to infer from its utility for the scientist its status as a metaphysical truth. Rather we can frame its utility in hypothetical terms: *If* we want to measure temperature, *then* we must employ the principle. And in cases where such pragmatic reasons are unclear or unconvincing, there is no obvious reason why the naturalized metaphysician cannot accept a pluralism about the metaphysical theories which arise from the empirical content of differing antecedent a priori principles.

References

- David Bohm. *Wholeness and the Implicate Order*. Routledge, 1980.
- Anjan Chakravartty. *A Metaphysics for Scientific Realism: Knowing the Unobservable*. Cambridge University Press, 2007.
- Anjan Chakravartty. Naturalized metaphysics. In Don Ross, James Ladyman, and Harold Kincaid, editors, *Scientific Metaphysics*, page 27. Oxford University Press, 2013.
- Hasok Chang. *Inventing Temperature: Measurement and Scientific Progress*. OUP USA, 2004.
- Hasok Chang. Contingent transcendental arguments for metaphysical principles. *Royal Institute of Philosophy Supplement*, 83(63):113–133, 2008.
- John Dewey. *The Influence of Darwin on Philosophy*. Bloomington, Indiana University Press, 1910.
- Arthur Stanley Eddington. *The Nature of the Physical World*. London, Dent, 1955.
- Michael Friedman. *Dynamics of Reason: The 1999 Kant Lectures at Stanford University*. Csl Publications, 2001.
- Norwood Russell Hanson. *Patterns of Discovery*, volume 11. Cambridge [Eng.]University Press, 1958.
- James Ladyman. Does physics answer metaphysical questions? *Royal Institute of Philosophy Supplement*, 82(61):179–201, 2007.

- James Ladyman and Don Ross. *Every Thing Must Go: Metaphysics Naturalized*. Oxford University Press, 2007.
- Tim Maudlin. *The Metaphysics Within Physics*. Oxford University Press, 2007.
- Alyssa Ney. Neo-positivist metaphysics. *Philosophical Studies*, 160(1):53–78, 2012.
- L. A. Paul. Metaphysics as modeling: The handmaiden’s tale. *Philosophical Studies*, 160(1):1–29, 2012.
- Hilary Putnam. Time and physical geometry. *Journal of Philosophy*, 64(8):240–247, 1967.
- Willard V. O. Quine. Two dogmas of empiricism. *Philosophical Review*, 60(1):20–43, 1951.
- Don Ross, James Ladyman, and Harold Kincaid. *Scientific Metaphysics*. Oxford University Press, 2013.