

Logic and/of Truthmaking

Jamin Asay

The University of Hong Kong

asay@hku.hk

Forthcoming in *Non-classical Logic, Structural Modelling and Meaning: The Proceedings of the Second Taiwan Philosophical Logic Colloquium TPLC-2014*, eds. D. M. Deng, Hanti Lin, and Syraya C. M.

Yang. Berlin: Springer-Verlag

Abstract

The purpose of this paper is to explore the question of how truthmaker theorists ought to think about their subject in relation to logic. Regarding logic *and* truthmaking, I defend the view that considerations drawn from advances in modal logic have little bearing on the legitimacy of truthmaker theory. To do so, I respond to objections Timothy Williamson has lodged against truthmaker theory. As for the logic *of* truthmaking, I show how the project of understanding the logical features of the truthmaking relation has led to an apparent impasse. I offer a new perspective on the logic of truthmaking that both explains the problem and offers a way out.

1. Introduction

What can logic teach us about truthmaking, and what can truthmaking teach us about logic? These are the questions I seek to address in this paper, which I intend to contribute to the more general ongoing discussion over the relationship between logic and metaphysics. I defend the view that while logic has no immediate implications for the theory of truthmaking (contrary to the view of several contemporary philosophers), addressing particular questions about the logic of truthmaking can help us better understand the metaphysical project that motivates and drives truthmaker theorists.

In the first main part of the paper, I explore some dimensions of the relationship between logic *and* truthmaking. Some have argued that key considerations drawn from logic all but refute the theory of truthmaking—such is the view defended by Timothy Williamson (1999). I defend truthmaker theory against such objections, and argue that, in principle, no such argument could be successfully developed. As a result, metaphysical inquiries such as truthmaker theory enjoy a limited kind of autonomy from logical investigation.

I then turn to the logic *of* truthmaking. If truthmaker theory can be rescued from the sorts of logical attacks I address in the first part of the paper, then the notion of truthmaking is legitimate. Accordingly, we should seek to understand its logical features. The project of developing a theory of the logic of truthmaking has been underway for some time, but has led to a seemingly irresolvable deadlock. I offer a new perspective on the logic of truthmaking that both explains the impasse and offers a way out.

2. Truthmaker Theory

Before turning to the relationship between logic and truthmaker theory, it will be worthwhile to pause briefly on the nature of the latter. ‘Truthmaker theory’ means a variety of things to a variety of people. As I shall understand it, truthmaker theory is a kind of metaphysical inquiry that subscribes to the belief that progress can be made in metaphysics by exploring what sorts of ontological posits are necessary in order to account for what is true. Truthmakers are the objects in reality in virtue of which truths are true. Because those truthmaking objects exist, the truths in question are true. So far, I shall suppose, all truthmaker theorists for the most part agree. Where they disagree is over which truths have truthmakers, what those truthmakers are, and how we are to account for the relation that obtains between a truth and its truthmakers. Sorting out those sorts of disputes is the bread and butter of those engaged in the truthmaking industry.

To take an example, consider that, necessarily, copper conducts electricity. Truthmaker theorists offer something in reality whose existence properly accounts for the truth in question. David Armstrong (1983), for instance, argues that what makes it true that copper necessarily conducts electricity is (something along the lines of) a state of affairs composed of the universal *copper* and the universal *electrically conductive* standing in the second-order relational universal *necessitation*. There is a relation of necessitation, in other words, between the two properties of being made of copper and being electrically conductive. Because that state of affairs exists, anything composed of copper must also be electrically conductive, and hence it will be true that copper necessarily conducts electricity. Had *copper* failed to stand in the necessitation relation to *electrically conductive* (as it does to, say, *having atomic number 28*), then it wouldn’t be necessary that copper conducts electricity. Of course, many dispute Armstrong’s particular metaphysical account of the truthmakers for laws of nature. But what everyone can acknowledge is that Armstrong, like all truthmaker theorists, is trying to come to terms with the proper ontological grounds that are necessary for understanding why certain claims are true. One can still sense the need for *something* to make true the laws of nature, even if one doesn’t find Armstrong’s own account compelling.

Truthmaker theorists, then, engage metaphysics by asking after what the truthmakers are for different truths. What makes counterfactuals true? Negative truths? Truths about possibility and necessity? Truthmaking questions can also extend into metaethics (what makes moral judgments true?), mathematics (what makes mathematical claims true?), and any other area of philosophy where metaphysical quandaries arise. (See, respectively, Asay 2013c and Baron 2013).

3. Logic and Truthmaking

Not everyone is compelled by truthmaking as a metaphysical methodology. One particularly severe critic is Williamson (1999), who has argued forcefully against the feasibility of truthmaker theory. In particular, he argues that certain compelling considerations drawn from modal logic demonstrate that truthmaker theory is incoherent. His objections are quite devastating if correct, and no one in the truthmaking literature has yet fully answered them or even really addressed them. In this section, I rebut Williamson's argument, and argue instead that no such argumentative strategy can succeed. Purely logical considerations cannot in and of themselves undermine metaphysical theories like truthmaking.

3.1. Williamson's argument

Williamson's argument against truthmaker theory is simple and straightforward. He begins by articulating a thesis that he calls the 'truthmaker principle', and then argues that it is inconsistent with the converse Barcan formula. But because the converse Barcan formula is true, the truthmaker principle (which is independently implausible anyway) must be false. Williamson's argumentative strategy is clear; he understands his argument as a contribution to "modal metaphysics disciplined by the rigour of modern logic" (1999: 253). In this particular conflict between a principle of logic and a principle of metaphysics, logic triumphs.

Let us examine Williamson's argument in more detail. First consider the principle he calls the 'truthmaker principle'. It is a form of *truthmaker maximalism*, the view that all truths have truthmakers. This thesis, while adopted by many truthmaker theorists, is not universally accepted in the truthmaking community. Some have argued, for instance, that negative existentials lack truthmakers (e.g., Bigelow 1988 and Lewis 2001). Non-maximalists could, in principle, accept Williamson's argument, as they agree that the maximalist truthmaker principle is false. But, as we shall see, Williamson's argument poses severe challenges to *any* truth with a truthmaker, regardless of whether or not all truths have truthmakers. Williamson presents the key principle under

discussion as the view that, necessarily, if something is true, then there is something that exists whose existence, necessarily, guarantees that the truth in question is true. For example, since it's true that there are pandas, there must be an object that is such that, if it exists, it's true that there are pandas. Any particular panda lounging in the forests of Sichuan province would seem to provide the requisite credentials to be a truthmaker. Note that Williamson presents the view as placing only a necessary condition on truthmaking: if X is a truthmaker for Y, then X's existence must necessitate the truth of Y. Whether or not it must do something else is of no concern to Williamson, since this minimal requirement is enough to fuel his argument.

The converse Barcan formula, meanwhile, asserts the following: if, necessarily, everything is F, then everything is necessarily F. As Williamson shows, it's a consequence of the converse Barcan formula that everything that exists exists necessarily. This result, combined with the truthmaker principle above, leads to what Williamson calls "modal collapse" (1999: 264). Suppose Penelope is one of those pandas in the forest. Since Penelope exists, she necessarily exists, by the converse Barcan formula. But the truthmaker principle holds that if Penelope makes it true that there are pandas, then in any possibility in which Penelope exists, it will be true that pandas exist. Penelope exists in every possibility, and so it turns out to be necessarily true that there are pandas. Moreover, if *every* truth has a necessitating truthmaker, and each of those truthmakers exist necessarily, then every truth is necessary: modal collapse. Any truth with a truthmaker turns out to be necessary; that's trouble enough for any truthmaker theorist, even one who rejects the view that all truths have truthmakers.

In response to the inconsistency, Williamson opts for the converse Barcan formula over the truthmaker principle. As for the former, he doesn't say much by way of positively defending it in the context of his anti-truthmaking argument; he relegates those arguments to elsewhere (e.g., Williamson 1998). Williamson does highlight some of the awkward consequences of denying it, and claims that supposed counterexamples to its necessary existence consequence (presumably, every object of ordinary experience, among others) can be resolved by attending to equivocation on the word 'exist' (1999: 267). Furthermore, he points out that accepting the converse Barcan formula allows one to be more "bold" with one's quantified modal logic (1999: 264). Where Williamson devotes more time is in undermining the motivations for the truthmaking principle. If the choice is between an unmotivated principle of metaphysics and a highly plausible theorem of logic, then the superior alternative should be immediately obvious.

Williamson's anti-truthmaking strategy is to find an innocuous substitute principle that preserves the intent behind the truthmaker principle without succumbing to its problematic metaphysical consequences. The truthmaker principle he seeks to reject is formalized as follows:

$$(TM) \quad \Box(A \supset \exists x \Box(\exists y x=y \supset A))$$

Again, what (TM) says is that, necessarily, if some claim is true, then there is some object such that, necessarily, if that object exists, then the claim is true. This is one way of capturing the thought behind the words ‘if something is true, there must be *something* that makes it true’, which Williamson accepts to be the platitudinous foundation of truthmaker theory. Williamson even allows that the platitude is true, at least on some reading. What Williamson makes a point of noticing is that the word ‘something’ in the platitude is interpreted by truthmaker theorists as a kind of objectual quantification. Hence, (TM) requires that any time something is true, there must be some existing object whose existence guarantees the truth of the truth in question.

In response to this understanding of the idea behind truthmaking, Williamson poses a rhetorical question: “Why not treat the platitude as simply connecting the constant *A* in sentence position with a variable in sentence position?” (1999: 258). In other words, Williamson suggests precisifying the basic thought behind truthmaker theory without resort to objectual quantification, and offers instead the following:

$$(TM^*) \quad \Box(A \supset \exists p(p \ \& \ \Box(p \supset A)))$$

All (TM*) asserts is that, necessarily, if *A* is true, then there is “something” (in a non-objectual sense) that is true and whose truth is sufficient, necessarily, for the truth of *A*. As Williamson points out, (TM*) is a logical truth, and doesn’t carry the ontological implications of (TM). For example, suppose Penelope weighs two hundred pounds. (TM) requires there to be some object whose existence necessitates the fact that Penelope weighs two hundred pounds. Penelope herself is not such an object, since she might have existed and yet still have weighed somewhat more or less. (TM) requires a further object, such as a state of affairs or trope—objects that Williamson declares to be of “unobvious standing” (1999: 264)—that does guarantee that Penelope weighs two hundred pounds. (See Armstrong 2004 for a development of this style of argument.) By contrast, (TM*) requires no such ontological posit. Simply substitute ‘Penelope weighs two hundred pounds’ for ‘*p*’. After all, necessarily, if Penelope weighs two hundred pounds, then Penelope weighs two hundred pounds. According to Williamson, then, (TM*) captures the basic thought behind truthmaker theory without its ontological extravagances.

3.2. Objections to the argument

We have now seen Williamson's anti-truthmaking argument in full. I offer two different sorts of rebuttal. First, I challenge a number of the premises of his argument. Second, I contest the overall rhetorical strategy of his argument, and its intention to discipline metaphysical inquiry by way of logical expertise.

Williamson's argument comes down to the inconsistency between (TM) and the converse Barcan formula, and the superiority of the latter. I shall focus my objections on the second pillar of the argument. As Williamson mostly relegates his support of the converse Barcan formula to elsewhere, so too will I mostly suppress my resistance to it. Any principle that entails that I am a necessary existent is extremely suspect, but I shall set aside that line of criticism for another time. I do note that there is no reason to believe that "boldness" in one's logic is more conducive to truth than being "bold" in one's metaphysical views. Williamson's preference for bold logic over bold metaphysics may well be indicative of his understanding of the relationship between logic and metaphysics, but it hardly counts as an independent argument in favor of one's logical system when it's under fire from competing views.

The bulk of my criticism is thus directed at Williamson's attack on (TM). Recall that he makes the familiar argumentative move of claiming that (TM) is an unwarranted attempt at capturing a simple platitude, given that it can be articulated by the more modest (TM*). However, there is no reason to think that (TM*) expresses anything like the basic idea driving truthmaker theory. Williamson does not offer any reason himself; he introduces (TM*) by way of the rhetorical question above, and proceeds as if the burden is on others to explain why (TM*) is insufficient as a truthmaker principle. Thankfully, that burden is rather easily met. Truthmaker theorists start from the idea that things get to be true by way of reality. Put another way, the truth-theoretic features of our world (i.e., which propositions, sentences, beliefs, or what have you are true or false) are dependent upon the non-truth-theoretic features of our world: what exists, and what properties those existing objects have. The truthmaking relation is then understood as one that obtains between a truth bearer and something from one's ontology. When truthmaker theorists ask after the truthmaker for the proposition that there are pandas, they are looking for an object—like Penelope—whose existence properly accounts for the truth of the proposition. (TM) captures this sentiment by requiring that when something is true, at the least there must be a sufficient ontological basis for it. Hence, truthmaker theorists adopt principles like (TM) and their use of objectual quantification. Truthmakers are the *objects* in reality that ground the truth values of truth bearers.

If truthmakers were not existing objects, but simply further truth-theoretic entities or facts, then the intended explanation of truth by way of ontology has not yet been given. (TM*), in stark contrast with (TM), claims that when something is true, there is something (read, again, non-objectually) whose truth is sufficient for the initial truth. Truthmaker theorists agree, but maintain that this observation completely misses the point. One does not answer a truthmaking inquiry for a given truth by pointing to another (or the same, as (TM*) seems to allow) truth. Williamson has left completely unexplained how adopting (TM*) and ditching the appeal to objectual quantification can satisfy the idea that what's true depends upon what exists. He is correct to notice that truthmaker theorists use quantificational language in expressing the basic pull behind the idea of truthmaking; but it doesn't follow that any analysis of that quantification is sufficient for capturing the intended thought. (TM) satisfies the main goal of truthmaker theory by relating truths with objects in the world. By abandoning objectual quantification, (TM*) removes any possibility for doing the same.

The objectual quantification invoked by (TM) is, therefore, fundamental to the truthmaking enterprise, as it guarantees that truths are being accounted for by way of being. (TM) ensures ontological accountability. (TM*), by comparison, is ontologically silent. Consider again the fact that there are pandas. The advocate of (TM) notes that anyone with a clear ontological conscience who accepts this truth must also accept an ontology that properly grounds it, such as an ontology with pandas. (TM*) imposes no similar burden. Someone might agree that there are pandas, and cite other claims they agree with that entail that there are pandas (such as that there are pandas that live in Sichuan), in accordance with (TM*). But suppose this person has an ontological aversion to creatures like Penelope and her conspecifics. This person strikes all such things from his or her ontology. In fact, this person insists that *nothing* needs to exist in order for it to be true that there are pandas: one must just commit to some claim that entails that there are pandas. Truthmaker theorists see foul play here: one cannot accept that it's true that there are pandas and yet accept no panda into her ontology without succumbing to the worst sort of ontological bad faith. But such a person has fully respected (TM*), which, after all, says nothing about how truth is related to ontology. Should one insist that it's simply impossible or incoherent to accept the truth that there are pandas while rejecting pandas from one's ontology, this can only be because one is assuming that there are connections that must be drawn between truth and ontology, connections which (TM*) does not assert but which truthmaker theorists insist must be respected. (TM*) is an ontologically impotent principle. Williamson agrees, and finds this to be its key virtue. Yet (TM*), precisely because of its innocuousness, has no ability to account for the basic insight behind truthmaking. Perhaps Williamson feels no such pull; if so, he's not alone, as

there's no shortage of critics of truthmaker theory. But to think that (TM*) speaks at all to the concerns of those who do feel truthmaking's appeal is simply indefensible.¹

Williamson writes as if it's the *words* 'Something makes a proposition true' that we know are true, though the thought expressed by the words is somehow ethereal and mysterious, such that it's spoils to the victor for whoever can defend the ontologically lightest version of what the sentence might plausibly express. But unless we have a fair grasp of what the words mean, there's nothing to find intuitive or compelling. A sentence can hardly be intuitive if we're quite unclear about what it expresses; at the least, finding an unclear sentence intuitive is worth very little weight in any rational inquiry. It's unfortunate that Williamson uncharitably reads his truthmaking opponents as being so unreflective regarding the basic concept motivating their project. Simply put, Williamson vastly underestimates truthmaker theorists' ability to articulate the basic idea that drives their metaphysical program. As a result, they are highly unlikely to take the bait Williamson offers with (TM*).

Hence, Williamson's claim that (TM*) offers a superior alternative to (TM) is baseless. If so, Williamson might still claim that (TM) is independently problematic, and so (TM*), while not offering a genuine replacement for (TM), is the best truthmaker theorists can have in a bad situation. Williamson's concern about (TM)—even setting aside its conflict with the converse Barcan formula—is that it leads truthmaker theorists to the “postulation of such individuals of unobvious standing” (1999: 264). He has in mind here entities like states of affairs and tropes, the sorts of objects that truthmaker theorists posit in order to ground the truth of contingent predications, negative existentials, and others. Such entities are indeed controversial, and some have argued for more austere, nominalistically friendly accounts of truthmaking (e.g., Lewis 2003 and Asay 2013b). Furthermore, one might argue for non-maximalist approaches to truthmaking that restrict the application of (TM), and similarly avoid postulating such entities (e.g., Lewis 2001).

¹ Williamson takes note of similar objections to the effect that (TM*) is not sufficiently ontologically weighty (1999: 262-264). His main response is to charge his critic with not allowing there to be a third, unexplained form of quantification that is neither objectual nor substitutional. The thrust of my comments is that it's quite obvious to all involved what sort of quantification is involved in truthmaking, and attempts to get truthmaking off the ground without it are doomed to fail. Williamson never even attempts to show how a non-ontologically binding quantifier can provide the intended ontological import required by truthmaker theory. Later, Williamson will respond to this thought by charging truthmaker theorists with “ignorance or neglect of the possibilities for non-nominal quantification” (2013: 402). Williamson is unwilling to concede that truthmaker theorists have some insight into what the commitments of their guiding idea is, and that it's one that requires ontological implications. If Williamson thinks that non-objectual quantification can save the day, he has not shown how, and so has not helped to dispel the ignorance he happily attributes to his colleagues.

In any event, truthmaker theorists fully admit that their posits are just that: ontological posits, appealed to in order to fulfill a particular theoretical demand for which they have argued. So of course they are “unobvious”; that fact is not in dispute, and this does not come as news. But the reason why Williamson’s charge falls particularly flat is that his ontological alternative is no less unobvious. According to Williamson, all beings—not just God, numbers, and propositions—are necessary beings. There are also some rather curious beings such as the thing that Wittgenstein could have but did not father (Williamson 1998: 258). Such a thing exists in the actual world, though not concretely, as it might have. Its existence is certainly no more obvious than the existence of the tropes that trope theorists say I’m looking at this very moment. Furthermore, in his attack on truthmaking, Williamson invokes “possible facts”. As Williamson conceives them, possible facts are truthmakers for falsities. This is rather surprising, given that falsities don’t have truthmakers; if they did, they wouldn’t be false. So falsities have no truthmakers, including entities called “possible facts”. For Williamson, possible facts exist, and they stand in a truthmaking relationship with falsities, though not in such a way as to render those falsities true. I, by contrast, reject such objects as being theoretically unnecessary and ontologically suspect.

Williamson rejects my outright denial of possible facts, because, he says, “We can sensibly ask ‘How many possible truthmakers are there for [a given falsehood]?’ in a sense in which the mere falsity of [that falsehood] does not answer our question” (1999: 268). In other words, Williamson here rejects the straightforward response that when something is false, nothing makes it true, and there literally is nothing that could have made it true. (If there were such a thing, it would have made the claim true, and so the falsity wouldn’t be false.) On Williamson’s alternative, there are things that could have made falsities true (raising the awkward question of why they don’t), or there are things like mere *possibilia*, which in some sense exist and in some other sense don’t. Williamson may well be happy to commit himself to a realm of entities that do not actually exist but still somehow manage to exist nonetheless. But there is absolutely no basis for the claim that these sorts of entities are obvious, when compared to truthmaker theorists’ tropes and states of affairs. According to Williamson, his non-concrete, non-spatiotemporal “possible facts” with their suppressed truthmaking powers are more ontologically obvious than, say, Armstrong’s concrete, actual facts (which he calls ‘states of affairs’), which are located in space and time and constructed from the very materials given to us in empirical experience. Williamson’s ontology may be correct, but he scores no points for obviousness.²

² Without doubt, Williamson would take issue with my casual wielding of ‘exist’, a word he oddly would prefer to be stricken from philosophy (1998: 259). That may be so, and attention to casual presuppositions concerning quantification in natural language is essential. But my purpose here is not to claim that the truthmaker theorist’s view

Hence, Williamson is in no position to claim that his preferred metaphysics is somehow less ontologically unobvious than the truthmaker theorists'. While this may be a rather small point, it does reveal a defect in Williamson's overall rhetorical strategy. Recall that he understands his argument to be an advance in metaphysics when shown the light by good attention to logic. But what closer inspection reveals is that his logic-first approach to metaphysics is already deeply metaphysically-laden. This comes as no surprise to Williamson, of course, as he uses modal logic as a tool for developing and defending his preferred metaphysical views (e.g., Williamson 2013 and 2014). Yet Williamson also believes himself to have shown that truthmaker theory is incoherent, because of the converse Barcan formula. In fact, however, the most he has shown is that anyone who accepts the converse Barcan formula must reject truthmaker theory as being incoherent. As a result, Williamson is guilty of dialectical overreach.³ There are probably countless modal logics that are inconsistent with truthmaker theory (and other metaphysical theories). Truthmaker theorists should respond that such modal logics aren't correct; they should say the same thing about the converse Barcan formula.

More generally, one's preferred modal logic is either neutral or committed with respect to the tenability of truthmaker theory. If the logic is neutral, then considerations drawn from it will have no bearing on the truth or falsity of truthmaker theory. If the logic is inconsistent with it, then the logic carries its own metaphysical baggage, and those metaphysical implications receive no special priority simply because they're associated with some particular logic. Anyone who wields a logic with the intent of attacking a metaphysical view is, to borrow Bradley's phrase, a "brother metaphysician". As a result, there seems to be no reason to think that logic has any special implications for metaphysical theories like truthmaker theory, or any other special status not belonging to any other realm of inquiry. Of course, if truthmaker theory contradicts some true theorem of logic, then truthmaker theory is false. But by the same token, if truthmaker theory contradicts some true claim of physics, then truthmaker theory is false. Logic has no privileged role to play in assessing truthmaker theory.⁴

is true, or doesn't face problems of its own; it's simply to demonstrate that Williamson's implication that his requisite ontology is somehow more obvious is meritless.

³ This is a charge he may well now accept. In his subsequent discussion of truthmaking (2013: 391-403), Williamson frames the discussion as why those who accept his metaphysical views must reject truthmakers, rather than as a direct assault on truthmaker theory itself. So perhaps he would now concede my objection. He does in addition repeat his arguments to the effect that truthmaker theory is unmotivated, though they suffer the same problems addressed above.

⁴ Williamson, in later work (2013), has developed a substantial metaphysical methodology that places enormous weight on considerations dealing with quantified modal logic, and it is not my intent here to claim to have undermined that much larger project. I certainly have offered no competing metaphysical methodology. My intent is merely to show

4. The Logic of Truthmaker Theory

In the previous section, I argued that truthmaker theory's tenability is not immediately threatened by its inconsistency with particular logical views. Logic and metaphysics enjoy a kind of independence from one another: when conflicts arise, neither field enjoys a privileged position. Or, perhaps to put the point more accurately, logic and metaphysics are already intertwined with one another, and so neither emerges as an Archimedean point by which to judge the other. In this section, I turn to the logic *of* truthmaking. Given the viability of the notion of a truthmaker, we want to have an account of how best to reason with it. If an object is a truthmaker for some truth bearer, what sorts of further inferences may we draw? Research on this topic has been quite fruitful, but has led to a deadlock. My contention is that there is a deep lesson about the nature of truthmaking to be learned by attending to this seemingly irresolvable conflict about the correct logic of truthmaking. How one conceives of the logic of truthmaking is fundamentally connected to how one conceives of the very point and purpose of truthmaking.

4.1. Some (conflicting) truthmaking principles

One way to think about the logic of truthmaking is to consider some of the logical principles that help explain how the truthmaking relation works. Many of these have been articulated and defended in the literature. First consider this pair of disjunction principles:

- (D₁) If T makes true $\langle P \vee Q \rangle$, then T makes true $\langle P \rangle$ or T makes true $\langle Q \rangle$.⁵
- (D₂) If T makes true $\langle P \rangle$ or T makes true $\langle Q \rangle$, then T makes true $\langle P \vee Q \rangle$.

(D₂) has been with truthmaker theory from the beginning (see Russell 1919: 39). (D₁), as we shall see, is quite contentious. Consider also the similar pair of conjunction principles:

- (C₁) If T makes true $\langle P \wedge Q \rangle$, then T makes true $\langle P \rangle$ and T makes true $\langle Q \rangle$.

why Williamson's purported refutation of truthmaker theory falls well short of the mark. Truthmaker theorists have no independent reason to accept the converse Barcan formula, and Williamson's challenges to the independent reasons to accept truthmaker theory are quite shallow. For direct criticism of Williamson's project, see Sullivan 2014. For an alternative view more sympathetic to truthmaking that also draws tight connections between logic and metaphysics, see Angere (forthcoming).

⁵ ' $\langle p \rangle$ ' is shorthand for 'the proposition that p '.

(C₂) If T makes true <P> and T makes true <Q>, then T makes true <P ∧ Q>.

The second principle is again less controversial than the first. Notice that (C₁), like (D₂), follows from a more general principle, the entailment principle, which has also been much discussed:

(E) If T makes true <P> and <P> entails <Q>, then T makes true <Q>.

All of these principles have struck some in the truthmaking literature as fairly compelling. But it's well known that together they produce a devastating conclusion. (The argument is originally due to Restall 1996.) According to standard models of entailment, every contingent truth entails every necessary truth, including the instances of the law of excluded middle. For example, <Pandas exist> entails <Gophers are amphibians or gophers are not amphibians> because it's impossible for the former to be true and the latter false (simply because it's impossible for the latter to be false). Suppose again that Penelope is a truthmaker for <Pandas exist>. By (E), she is also a truthmaker for <Gophers are amphibians or gophers are not amphibians>. By (D₁), we infer that Penelope is a truthmaker for either <Gophers are amphibians> or <Gophers are not amphibians>. We know that <Gophers are amphibians> is false, and has no truthmaker, so Penelope is a truthmaker for <Gophers are not amphibians>. Generalizing away, we see that every truthmaker is a truthmaker for every truth.

Responses to this argument run the gamut. One might reject (D₁): truthmakers for disjunctions aren't necessarily truthmakers for the disjuncts (e.g., Read 2000, López de Sa 2009, and Talasiewicz et al. 2013). One might accept (E), but only on a reading of entailment that denies that everything entails necessary truths (e.g., Restall 1996 and Armstrong 2004). Gonzalo Rodriguez-Pereyra (2006, 2009) accepts (D₁) but rejects (E) outright, regardless of how entailment is understood (cf. Tahko and O'Conaill (forthcoming)). He has a number of reasons for doing so, most notably because (E) entails (C₁), which he thinks is false. (See Jago 2009 for an argument that this combination of positions is unstable.) His view will provide the central focus of my discussion of how the logic of truthmaking can help us understand the nature of truthmaking.

Rodriguez-Pereyra's central contention is that (C₁) is open to counterexample. Take the conjunction <There are pandas and there are gophers>. Suppose Goober is a gopher. One plausible truthmaker for the conjunction is something along the lines of the mereological sum Penelope + Goober. However, Penelope + Goober is *not*, says Rodriguez-Pereyra, a truthmaker for either <There are pandas> or <There are gophers>, despite being a truthmaker for their conjunction. Neither proposition, he reasons, is true in virtue of that mereological sum. Indeed,

they are true in virtue of parts of that sum, but not the complete sum. So the sum is not a truthmaker for the individual conjuncts. Hence, Rodriguez-Pereyra concludes that (C₁), and (E) along with it, are false.

A more common view of these kinds of cases is that while Penelope + Goober is not the *only*, or the most *minimal* truthmaker for the individual conjuncts, it is one of their truthmakers nevertheless.⁶ After all, truths need not have just a single truthmaker, and the existence of the mereological sum metaphysically guarantees the truth of both conjuncts. Against this reasoning, Rodriguez-Pereyra maintains that “a conjunctive fact is what a certain proposition is true in virtue of only if *all* the conjuncts contribute to the truth of the proposition. When some but not all the conjuncts of a conjunctive fact contribute to the truth of a certain proposition, the proposition is true in virtue of a part of the conjunctive fact, but not in virtue of the conjunctive fact itself” (2006: 972). The basic idea is that the mereological sum contains extraneous parts that are completely irrelevant to the truth of the proposition in question. Because truthmaking is a relation that accounts for what parts of reality genuinely make true a proposition, the inclusion of excess ontology disqualifies the entity from being a truthmaker. <There are pandas> is not true in virtue of Goober in any way at all, and so is not true in virtue of anything which includes Goober even as a part.

At this juncture, we may appear to be at an impasse, or simply a clash of intuitions. There are those who, like Armstrong and López de Sa, judge that Penelope + Goober is a truthmaker for <There are pandas>, and so see no problem with (C₁). And there is Rodriguez-Pereyra, who judges that it’s not a truthmaker, and so rejects both (C₁) and (E). Both camps are aware of the extraneous parts belonging to Penelope + Goober. Where they disagree is whether or not that nullifies the truthmaking in question. It’s unclear what further source of evidence one could consult to settle the matter, so it’s tempting to conclude that there’s nothing more to be said than that the two parties, equipped with irreconcilable judgments, must agree to disagree. I, however, find this response quite unsatisfying. In fact, I believe we can discern a fairly fundamental lesson for truthmaker theory here by analyzing the disagreement. The reason why the two camps diverge lies in what they conceive the main goals of truthmaker theory to be.

⁶ See Tahko and O’Conaill (forthcoming) for an account of minimal truthmakers.

4.2. Two approaches to truthmaking

Rodriguez-Pereyra sees in the notion of truthmaking a special kind of matching. For any given truth, there are parts of reality that are relevant to its being true, and parts that are irrelevant. The goal of truthmaker theory, so conceived, is to determine which truths match which parts of reality. Failing to discern the appropriate matching means that the truth in question is left unaccounted for. At the risk of deploying an overused and widely abused term, one way of describing Rodriguez-Pereyra's understanding of truthmaking is as of being a kind of *explanatory* project. Faced with some truth, that truth is to be explained by the parts of reality that are responsible for its truth. If a proffered truthmaker contains extraneous parts, we've given a bad explanation: the truth isn't true in virtue of *that* slice of reality; it's some other portion that is responsible. So conceived, truthmaker theory seeks to give a special kind of ontological explanation to truths. The upshot is that truths and their truthmakers must fit together just right; there is little flexibility in the relationship between a truth and its ontological ground. The idea, it seems to me, is highly reminiscent of the traditional correspondence theory of truth, which also relied on a close kind of matching between truths and facts (or whatever the corresponding objects were supposed to be). Whether that matching was a kind of congruence between truth and object or some sort of correlation was up for debate. (See Kirkham 1992: 119-120.) The explanatory approach takes truthmaker theory's business to be offering a necessary kind of explanation of truths, much as the traditional correspondence theory did.⁷

Consider now a different entry into the idea of truthmaking. Armstrong reports that his initial attraction to the idea of a truthmaker came from his (and Charlie Martin's) assessment of the failings of metaphysical views like behaviorism and phenomenalism (2004: 1-3). These views happily committed to certain counterfactual truths like <If I were to go to the quad, I would have a sense impression of a tree> and <If I were asked the capital of Argentina, I would answer 'Buenos Aires'>; they might even "reduce" the existence of ontological posits like unperceived objects and mental states down to the truth of such counterfactuals. But to take such claims as true, but deny that there is any underlying reality that makes them true, is to treat the counterfactuals as brute truths—truths that "float free" of reality. The existence of such inexplicable truths is no improvement over the alternative of accepting the straightforward ontological commitments that accompany the counterfactuals. In the previous section, I

⁷ Which is not to say that all theories of truthmaking are attempts at theories of truth. On my view, explaining the nature of truth itself and the nature of truthmakers are independent philosophical projects, though they can come together (as they do in the traditional theories of truth). See Asay 2013a: 125-127.

highlighted the even less tenable view that accepts <There are pandas> as true while refusing to ontologically commit to any pandas. Truthmaker theorists find fault with anyone who is willing to commit to certain truths but unwilling to commit to a sufficient ontological basis for them. This way of thinking about truthmaking presents it as a kind of ontological *accounting*: the theories we accept as true impose crucial constraints on what sorts of ontologies we are entitled to accept. Truthmaking as accounting keeps us ontologically honest: we consider and commit to the right kind of ontology that can fund all the claims we take to be true. With the accounting idea in mind, it makes sense why adding extraneous parts to a truthmaker doesn't destroy its truthmaking capacities. If the truth of <There are pandas> is fully accounted for by Penelope, then it's fully accounted for by Penelope + Goober. Those who offer the mereological sum as a truthmaker for the conjunction have done their ontological due diligence; no one can accuse them of cheating on their ontological taxes, as it were.

My hypothesis for explaining the deadlock between theorists like Rodriguez-Pereyra and theorists like Armstrong and López de Sa is that because both conceptions of truthmaking are operant in the literature, and they haven't been cleanly distinguished from each other, they inform our judgments about particular cases in multiple and sometimes conflicting ways. As a result, there is no universally agreed upon conception of why truthmaking is important, what its theoretical roles are, and how theories of truthmaking should be developed. To conclude my remarks, I'd like to consider some of the issues raised by drawing this distinction between explanatory and accounting truthmaking, and how we might move forward from here.

4.3. Moving forward

First, I'd like to stress that my view isn't simply that Rodriguez-Pereyra and Armstrong and the others are talking past one another. That they have different philosophical views about the nature of the truthmaking relation does not show that they're engaged merely in a verbal dispute. I am suggesting that the very clear disagreement they have—over the status of purported counterexamples to (C₁)—is best explained by presuppositions about the enterprise that have not been fully articulated. Now, the ideas behind both the explanatory and accounting notions of truthmaking are familiar and widespread; I'm not suggesting that truthmaker theorists have failed to notice these underlying approaches. To the contrary, I believe that both ideas have made an impact on all truthmaker theorists. The discussion of truthmaking as being a kind of explanatory relation is quite robust. (See, e.g., Smith and Simon 2007, Sanson and Caplan 2010, and Schulte 2013.) The notion of truthmaking as ontological accounting, on the other hand, fits well with the

idea of truthmaking as a kind of “cheater catching” (as defended by Merricks 2007), though I don’t care for the language of “cheating”. What hasn’t been noticed, I’m suggesting, is that these two angles on truthmaker theory are potentially in conflict with one another, and thus there is an underlying tension in the truthmaking literature that needs to be addressed. The explanatory and accounting notions are both widely in play in contemporary truthmaker theory, and while for most intents and purposes they are complementary approaches, they do inevitably butt heads, as demonstrated by the argument over (C₁).

One question that inevitably arises from drawing the contrast is: supposing the two genuinely do conflict, which notion is the correct account of the truthmaking relation? In response, I’m fairly wary of the idea that there is some privileged relation properly bearing the name ‘truthmaking’, and that of our two candidates, at most one of them is deserving of it. I think that a better analysis of the situation is that there is one relation—call it ‘T_E’—that Rodriguez-Pereyra detects between <There are pandas> and Penelope, but not between <There are pandas> and Penelope + Goober. And there is another relation—call it ‘T_A’—that Armstrong and others find obtaining between <There are pandas> on the one hand, and both Penelope and Penelope + Goober on the other. For both relations, we can ask whether they are theoretically illuminating, whether they hold for all or only some truths, whether they can answer important explanatory questions, and whether they deserve philosophical investigation and analysis. We can ask, in other words, about which relation deserves our attention as theorists interested in the kinds of metaphysical questions that truthmaker theorists have been exploring. Rodriguez-Pereyra would answer that T_A is not a particularly interesting relation; it at least doesn’t serve the purpose of explaining how truth bearers get to be true. Other theorists might respond that T_E simply doesn’t exist (there isn’t such a connection between truths and objects in the world), or that far fewer truths stand in it than theorists like Rodriguez-Pereyra suppose.

Though I cannot settle the matter here, I would like to voice a few considerations that suggest that truthmaker theory is better suited for embracing T_A as its core notion. First, taking T_E as the core truthmaking relation threatens to call into doubt some other paradigm instances of the truthmaking relation. For instance, Penelope is typically thought to stand in the truthmaking relation to <There are pandas>. What’s unclear is how we can explain how Penelope stands in T_E to <There are pandas>. The proposition <There are pandas> doesn’t appear to be true in virtue of *Penelope*. Certainly, Penelope’s existence isn’t necessary for the truth of <There are pandas>. Similarly, it’s odd to think that the truth of <There are pandas> depends upon the existence of Penelope. Penelope could never have existed, and yet that would have had no effect at all on the truth of <There are pandas>. That’s some reason to think that there’s no dependence at work

here. Yet truthmaking, at least understood along the lines of T_E , is a kind of dependence: truths depend on their truthmakers for their truth. What the truth of \langle There are pandas \rangle seems to depend on is there being some panda or other, not on Penelope or any other panda in particular. But ‘there being some panda or other’ is not the name of an entity—not of any uncontentious entity, anyway—and so it’s unclear why we should think that Penelope stands in T_E to \langle There are pandas \rangle . By contrast, it’s perfectly clear why Penelope stands in T_A to \langle There are pandas \rangle . Her existence is metaphysically sufficient for the truth of the proposition. An ontological commitment to Penelope is more than enough to account for the truth of \langle There are pandas \rangle . Theorists relying on T_A therefore have a much simpler time accounting for the judgment that Penelope is indeed a truthmaker for \langle There are pandas \rangle . \langle There are pandas \rangle might indeed stand in T_E to Penelope, but some work needs to be done to show why, and in a convincing and non-*ad hoc* way.

T_E theorists also face the challenge of articulating the kind of explanations that truthmakers are supposed to offer. Take, for instance, the fact that snow is white. Truthmaker theorists often make the claim that this fact (by which I mean ‘true truth bearer’) has a truthmaker, and that this truthmaker explains the truth of the fact. But here is another explanation, quickly found on the Internet:

Snow is a whole bunch of individual ice crystals arranged together. When a light photon enters a layer of snow, it goes through an ice crystal on the top, which changes its direction slightly and sends it on to a new ice crystal, which does the same thing. Basically, all the crystals bounce the light all around so that it comes right back out of the snow pile. It does the same thing to all the different light frequencies, so all colors of light are bounced back out. The “color” of all the frequencies in the visible spectrum combined in equal measure is white, so this is the color we see in snow, while it’s not the color we see in the individual ice crystals that form snow.⁸

This explanation, of course, makes no reference to truthmakers. Those skeptical of truthmaker theory will wonder why such explanations are insufficient for explaining the truth of \langle Snow is white \rangle . Truthmaker theorists might respond by insisting that there is a distinctive ontological kind of explanation that only truthmakers can speak to. In that case, we are owed an account of what this relation is, which must be something that goes above and beyond the T_A theorist’s accounting demand. I do not intend to claim that no such account can be given (but see Talasiewicz et al.

⁸ <http://science.howstuffworks.com/nature/climate-weather/atmospheric/question524.htm> (accessed 28 January, 2015).

2013: 601-603), but rather that this is a substantial hurdle faced by the advocate of T_E and avoided by adopting T_A .

Another challenge for T_E is developing a sufficiently precise account of the “matching” that the relation supposes to hold between truths and their truthmakers. If adding Goober to Penelope is enough to nullify Penelope’s being a truthmaker for \langle There are pandas \rangle , the question arises as to how much one can add or subtract to Penelope and still end up with a valid truthmaker. After all, one might consider Penelope herself to be a mereological sum, in which case we must ask whether she has any parts extraneous to the truth of \langle There are pandas \rangle . Presumably, Penelope could shed all sorts of parts (some fur, a limb, the bamboo currently digesting in her stomach) without sacrificing the truth of \langle There are pandas \rangle . But if so, then it seems that we should be tolerant of extraneous material belonging to Penelope. If Goober is indeed an extraneous addition gone too far, the T_E theorist owes us an explanation as to which parts, however negligible, disrupt or are required for the necessary matching to obtain. T_A theorists might face a similar question when it comes to accounting for an object’s *minimal* truthmakers: how much of Penelope can one subtract while still having a truthmaker for \langle There are pandas \rangle ? But T_A theorists are not committed to the view that all truths have minimal truthmakers: some might not have them at all (see Armstrong 2004: 21-22). Nor is their central theoretical concern finding minimal truthmakers for every truth. Honest ontological accounting comes first; exploring further details is a worthwhile enterprise, but not a matter that puts pressure on understanding the core relation of the whole theory.

Finally, one theoretical disadvantage facing the T_E theorist is that it may be more difficult to defend a non-maximalist truthmaker theory. Recall my suggestion that the tight connection that T_E assigns between truth and truthmaker is reminiscent of the traditional correspondence theory of truth. According to that theory, truths are explained by way of their standing in a particular relation of correspondence to parts of reality. The correspondence theory is a theory of *truth*; it takes the nature of truth to be something that requires a distinct kind of metaphysical explanation. That explanation is common for all truths: any and all truths are accounted for by way of their corresponding with reality. (The lack of a need for a common explanation of truths in this manner is the calling card of deflationary theories of truth.) There can be no “non-maximalist correspondence theory”: if truth *is* correspondence with reality, then something cannot be true without corresponding with reality. I detect a similar thought behind Rodriguez-Pereyra’s insistence that \langle There are pandas \rangle needs *Penelope*, not Penelope + Goober, in order to be true. When truthmaking moves beyond simply keeping your ontological books up to date, it wanders into the territory of taking *truth* itself to be something in need of a unique kind of metaphysical

explanation. If so, then taking some truths to lack truthmakers is at odds with the stronger truthmaking project represented by T_E . For such views, all truths need truthmakers because without them, the truth of truth bearers goes unexplained and unaccounted for.⁹

Maximalism is less necessary to truthmaking when equipped merely with T_A . If truthmaking is not out to explain the nature of truth itself, it is free to consider that when it comes to some truths, nothing ontologically is needed to properly ground them. The classic example is negative existential truths. It's true that there are no saber-toothed tigers left in 2015. As a negative existential, it makes a claim exclusively about what *doesn't* exist, and so it's at least non-trivial to claim that it needs something that *does* exist in order to be true. It is open, in principle, to the defender of T_A to think that some truths just don't need truthmakers. (Analytic truths are another potential example.) Now, the way to think about negative existentials is a longstanding and much-disputed (if not the most disputed) topic in truthmaker theory. My claim is that T_A gives us more theoretical flexibility in our thinking about the ontological implications of negative truths, since it's not committed to maximalism from the outset, as T_E appears to be.

One final implication of taking T_A as central to truthmaker theory is that it may offer some resistance to the now seemingly universal adoption of the view that not all objects make true necessary truths. The Grand Canyon, so says common wisdom, necessitates the truth of $\langle 7 + 5 = 12 \rangle$, but does not make it true. Most theorists accept this perspective on this and similar cases, and thus seek a hyperintensional account of the truthmaking relation. Even those who have developed the ontological accounting idea of truthmaking—notably Armstrong—feel the pull of the problem of necessary truths. But the problem is felt most keenly given T_E , as there's no apparent explanatory connection between America's most magnificent geological formation and Kant's favorite piece of arithmetic. If truthmaking is more about covering your ontological bases than it is about providing explanations of truth, then it becomes less obvious that necessary truths even need truthmakers. After all, many necessary truths appear not to depend on anything in order to be true—they would be true regardless of what does or doesn't exist.¹⁰ In any event, the important observation is that even prominent voices in the truthmaking literature are pulled both

⁹ As it turns out, Rodriguez-Pereyra at most commits himself to maximalism only with respect to some set of synthetic truths (2005: 18). I cannot say how he might respond to this line of reasoning that suggests an internal tension between his non-maximalism and adoption of something like T_E , as he has not directly argued for his restriction of truthmaking to a certain class of synthetic truths.

¹⁰ In my view, developed elsewhere, the distinction between analytic and synthetic truths is of greater relevance to the question of which truths have truthmakers than is the distinction between contingent and necessary truths. If there are synthetic necessary truths (e.g., $\langle \text{God exists} \rangle$), then they would seem to depend upon the existence of certain (necessary) beings. But the same is not obviously true for analytically necessary truths.

by T_A and T_E . If my contention that we cannot have both is correct, then some of the developed consensus in the literature needs rethinking.

All in all, I am suggesting that developing truthmaker theory along the lines of T_A instead of T_E is theoretically advantageous, and may bypass some of the worries and objections that have been offered against various kinds of truthmaker theories over the years. Ultimately, my claim is that our thinking about truthmaking has been drawing on the notions behind both T_A and T_E , and that this mixed source of ideas explains a variety of judgments that are taken for granted in the truthmaking literature. Yet this diverse spring of inspiration leads to conflict, since it's not obvious how to reconcile the inconsistencies that dwell within it. Analogously, it seems that our moral thinking has both utilitarian and deontological dimensions to it; it's this mixed bag that leads to compelling counterexamples to *both* kinds of theories. For truthmaker theory to make progress, it must also recognize these conflicts; only by doing so can it start to develop a systematic metaphysical theory.

Acknowledgments

Versions of this paper were presented at the Taiwan Philosophical Logic Colloquium at National Taiwan University in October 2014, and at the Korean Society for Analytic Philosophy and Pluralisms Global Research Network Workshop in Seoul in November 2014. My thanks go to the organizers and participants for their very constructive feedback, as well as to the referee for this volume, Maegan Fairchild, and Jack Yip for their helpful input and discussion of the material. The work described in this paper was substantially supported by a grant from the Research Grants Council of the Hong Kong Special Administrative Region, China (HKU 23400014).

References

- Angere, Staffan. Forthcoming. The logical structure of truthmaking. *Journal of Philosophical Logic*.
- Armstrong, D. M. 1983. *What is a Law of Nature?* Cambridge: Cambridge University Press.
- . 2004. *Truth and Truthmakers*. Cambridge: Cambridge University Press.
- Asay, Jamin. 2013a. *The Primitivist Theory of Truth*. Cambridge: Cambridge University Press.
- . 2013b. Truthmaking for modal skeptics. *Thought 2*: 303-312.
- . 2013c. Truthmaking, metaethics, and creeping minimalism. *Philosophical Studies* 163: 213-232.
- Baron, Sam. 2013. A truthmaker indispensability argument. *Synthese* 190: 2413-2427.

- Bigelow, John. 1988. *The Reality of Numbers: A Physicalist's Philosophy of Mathematics*. Oxford: Clarendon Press.
- Jago, Mark. 2009. The conjunction and disjunction theses. *Mind* (New Series) 118: 411-415.
- Kirkham, Richard L. 1992. *Theories of Truth: A Critical Introduction*. Cambridge: MIT Press.
- Lewis, David. 2001. Truthmaking and difference-making. *Noûs* 35: 602-615.
- . 2003. Things qua truthmakers. In *Real Metaphysics: Essays in Honour of D. H. Mellor*, eds. Hallvard Lillehammer and Gonzalo Rodriguez-Pereyra, 25-42. London: Routledge.
- López de Sa, Dan. 2009. Disjunctions, conjunctions, and their truthmakers. *Mind* (New Series) 118: 417-425.
- Merricks, Trenton. 2007. *Truth and Ontology*. Oxford: Clarendon Press.
- Read, Stephen. 2000. Truthmakers and the disjunction thesis. *Mind* (New Series) 109: 67-80.
- Restall, Greg. 1996. Truthmakers, entailment and necessity. *Australasian Journal of Philosophy* 74: 331-340.
- Rodriguez-Pereyra, Gonzalo. 2005. Why truthmakers. In *Truthmakers: The Contemporary Debate*, eds. Helen Beebe and Julian Dodd, 17-31. Oxford: Clarendon Press.
- . 2006. Truthmaking, entailment, and the conjunction thesis. *Mind* (New Series) 115: 957-982.
- . 2009. The disjunction and conjunction theses. *Mind* (New Series) 118: 427-443.
- Russell, Bertrand. 1919. The philosophy of logical atomism [lectures 3-4]. *The Monist* 29: 32-63.
- Sanson, David, and Ben Caplan. 2010. The way things were. *Philosophy and Phenomenological Research* 81: 24-39.
- Schulte, Peter. 2011. Truthmakers: a tale of two explanatory projects. *Synthese* 181: 413-431.
- Smith, Barry, and Jonathan Simon. 2007. Truthmaker explanations. In *Metaphysics and Truthmakers*, ed. Jean-Maurice Monnoyer, 79-98. Frankfurt: Ontos Verlag.
- Sullivan, Meghan. 2014. Modal logic as methodology. *Philosophy and Phenomenological Research* 88: 734-743.
- Tahko, Thomas E., and Donnchadh O'Conaill. Forthcoming. Minimal truthmakers. *Pacific Philosophical Quarterly*.
- Talasiewicz, Mieszko, Joanna Odrowąż-Sypniewska, Wojciech Wciórka, and Piotr Wilkin. 2013. Do we need a new theory of truthmaking? Some comments on Disjunction Thesis, Conjunction Thesis, Entailment Principle and explanation. *Philosophical Studies* 165: 591-604.
- Williamson, Timothy. 1998. Bare possibilities. *Erkenntnis* 48: 257-273.
- . 1999. Truthmakers and the converse Barcan formula. *Dialectica* 53: 253-270.
- . 2013. *Modal Logic as Metaphysics*. Oxford: Oxford University Press.

—. 2014. Logic, metalogic and neutrality. *Erkenntnis* 79: 211-231.