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Modal Semantics without Worlds*

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Abstract

Over the last half century, possible worlds have bled into almost every area of philosophy. In the metaphysics of modality, for example, philosophers have used possible worlds almost exclusively to illuminate discourse about metaphysical necessity and possibility. But recently some have grown dissatisfied with possible worlds. Why are horses necessarily mammals? Because the property of being a horse bears a special relationship to the property of being a mammal, they say. Not because every horse is a mammal in every possible world. Some have recently begun to use properties to develop rivals to possible worlds semantics which may someday compare in formal power and capture the different systems of modal logic. In this paper, I do two things. I first offer a quick primer on possible worlds semantics. Then I discuss three rivals and the work they have left to do.

1 Introduction

Over the last half century, possible worlds have bled into almost every area of philosophy. In the metaphysics of modality, for example, philosophers have used possible worlds almost exclusively to illuminate discourse about metaphysical necessity and possibility. For this monopoly on matters modal, we have to thank the unrivaled formal power of possible world semantics. Philosophers often formalize their discourse about metaphysical necessity and possibility within the language of modal logic. And possible worlds semantics best captures the different systems of modal logic. So philosophers naturally appeal to possible worlds when they discuss matters in modal metaphysics. These discussions are often channeled through the heart of possible worlds semantics, the characterization of necessary truth as truth in all possible worlds.

We can use a modal semantics as a purely formal tool to prove results about systems of modal logic. As a purely formal tool, a modal semantics doesn't treat the language of modal logic as being about modal reality, about what's metaphysically necessary or possible. Or we can use a modal semantics not only as a formal tool, but also as a way to link the language of modal logic to modal reality, as a way to model expressions in the language which we interpret as saying something about modal reality. Given certain purposes, possible worlds semantics may not be the best way to link modal logic to modal reality. For example, some philosophers have recently grown dissatisfied with possible

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worlds for metaphysical reasons. Why are horses necessarily mammals? Not because every horse is a mammal in every possible world. But because the property of being a horse bears a special relationship to the property of being a mammal, they say. These philosophers use properties instead of possible worlds to illuminate modal notions such as metaphysical necessity. And some have even begun to develop rivals to possible worlds semantics which may someday compare in formal power and capture the different systems of modal logic. In this paper, I do two things. I first offer a quick primer on possible worlds semantics. Then I discuss three rivals and the work they have left to do.

2 Possible Worlds Semantics

Possible worlds semantics offers two biconditionals to evaluate claims about the necessity or possibility of a proposition within modal logic:[1]

(N) ⌜necessarily, ϕ⌝ is true if and only if ⌜ϕ⌝ is true in every accessible possible world.[2]

(P) ⌜possibly, ϕ⌝ is true if an only if ⌜ϕ⌝ is true in at least one accessible possible world.[3]

(N) and (P) each have two features which help account for the formal power of possible worlds semantics. First, they treat the so-called modal operators 'necessarily, ...' and 'possibly, ...' as if they were quantifiers over possible worlds. The necessity operator, for example, functions like a universal quantifier. If we ignore accessibility for a moment, (N) implies that 'necessarily, 2 + 2 = 4' is true when '2 + 2 = 4' is true in every possible world. When we universally quantify in an everyday context and say something such as "everything is ruined," we may not mean that absolutely everything in the universe has been ruined. We may instead mean that all the clothes in the dryer have been ruined. We may restrict the quantifiers over possible worlds in a similar way. We may quantify restrictedly over morally ideal possible worlds (where no one violates any actual moral law), epistemically possible worlds (where nothing conflicts with what we

[1] I will focus here on applications of Saul Kripke's seminal 'Semantical Considerations on Modal Logic'. For more complete introductions to possible worlds semantics see Michael Loux's introduction to *The Possible and the Actual*, Christopher Menzel's 'Possible Worlds', and, finally, *A New Introduction to Modal Logic*, the classic text by Hughes and Cresswell. Although my focus here is how possible worlds semantics applies to modal logic, I also want to mention Angelika Kratzer's pioneering work which employs possible worlds to model the meanings of modal expressions in natural language. See Kratzer's 'What 'Must' and 'Can' Must and Can Mean' and 'The Notional Category of Modality', as well as Paul Porter's accessible explanation of her work in *Modality*, 47-85. Kratzer's work on natural language is another feather in the cap for possible worlds. Whether any rival to possible worlds semantics could account not only for the different systems of modal logic but also various expressions in natural language is an important question which I will largely ignore here. Of the rivals I will survey in this paper, only Barbara Vetter's (in Section 3) has made significant headway into both natural language and modal logic.

[2] When clarity permits, I will sacrifice these use-mention markers at the alter of readability.

[3] Philosophers often misleadingly call (N) and (P) Leibnizian Biconditionals. Although Leibniz developed the notion of a possible world in important ways, he offers other definitions of the modal notions. See Robert M. Adams, *Leibniz: Determinist, Theist, Idealist*, 3-52 and especially 46-50.

actually know), physically possible worlds (where nothing violates any actual physical law), or metaphysically possible worlds (where nothing violates any actual metaphysical law). Treating modal operators as more or less restricted quantifiers allows us to illuminate discourse about different kinds of modality:

Modality	**Sentence**	**True when ϕ is true in every**
DEONTIC	it's obligatory that ϕ	morally ideal possible world
EPISTEMIC	it's known that ϕ	epistemically possible world
PHYSICAL	it's physically necessary that ϕ	physically possible world
METAPHYSICAL	it's metaphysically necessary that ϕ	metaphysically possible world

Amidst all the different restrictions, possible worlds semantics pinpoints a feature common to each kind of necessity, from moral to metaphysical: being true in all possible worlds of a certain kind. Possible worlds semantics applies widely to different modal notions and yet treats those modal notions in the same general way.

A rival to possible worlds semantics which applies less widely might miss something important besides the obvious loss in systematicity. Suppose you build a rival semantics which covers metaphysical modality alone. Then someone might reasonably wonder what distinguishes metaphysical modality from the rest and why your semantics should cover the one but not the others. For perhaps the different modalities share some general feature which possible worlds semantics has more or less directly captured. The failure of a semantics to cover all but metaphysical modality may suggest that it fails to capture that general feature, not only in the other modalities, of course, but even in the intended target of metaphysical modality. None of the three rivals I consider apply as widely as possible worlds semantics. Since none do and none explicitly count wide applicability as a virtue any rival semantic framework must share with possible worlds semantics, I will save a brief discussion on the matter near the end of Section 4.

The accessibility relation (which we momentarily ignored above) is the second feature responsible for much of the formal power of possible worlds semantics. (N) and (P) already restrict the quantifiers to *accessible* possible worlds—ϕ is true in every/at least one accessible possible world. The accessibility relation governs which worlds access which. We can think of accessibility as relative possibility and of accessible worlds as relevant possibilities for ways the world might be. The possible worlds which our world accesses are the relevant possibilities for how things might have gone differently. So we needn't think of the accessibility relation between two worlds as a string hanging from one to the other, like a clothes line.

Different formal conditions on which worlds access which help capture the truth conditions of different modal principles. Consider, for example, the modal principle (T) that whatever is necessarily true is also true. (T) is true just in case the accessibility relation is reflexive (i.e., when every world accesses itself and presents itself as a relevant possibility). For if ϕ is necessarily true in a world w and therefore true in the all the worlds which w accesses, including itself, then ϕ is also true in w. Within the possible worlds framework, the truth of

some principle or other hangs on whether the accessibility relation meets the corresponding condition.

Here is a table with some more well-known modal principles on the left and their corresponding accessibility conditions on the right (where '$\Box\phi$' and '$\Diamond\phi$' say "necessarily, ϕ' and "possibly, ϕ," respectively, 'Rwu' says "world w accesses u," and '$\rightarrow$' is short for "if... then..."):

Modal Principle	**Accessibility is**	
(T) $\Box\phi \supset \phi$	Reflexive:	$\forall$wRww
(D) $\Box\phi \supset \Diamond\phi$	Serial:	$\forall$w$\exists$vRwv
(S4) $\Box\phi \supset \Box\Box\phi$	Transitive:	$\forall$w$\forall$v$\forall$u((Rwv & Rvu) $\rightarrow$ Rwu)
(S5) $\Diamond\phi \supset \Box\Diamond\phi$	Euclidean:	$\forall$w$\forall$v$\forall$u((Rwv & Rwu) $\rightarrow$ Rvu)

In the dark ages before possible worlds semantics, it wasn't clear what many modal principles meant or what their truth conditions were.[4] But as the table above helps show, possible worlds semantics tells us what modal reality would be like if one or another modal principle were true. Each modal principle corresponds to a condition on which worlds access which. If a certain modal principle is true, its corresponding condition holds; if a certain modal principle is false, its corresponding condition fails to hold. The accessibility relation's formal flexibility provides the truth conditions for various modal principles.

Any true rival to possible worlds semantics must match its formal flexibility and make sense of the various modal principles by providing truth conditions for them. Like possible worlds semantics, it should identify some distinctive feature for each modal principle that modal reality would exhibit if the principle were true. Otherwise, we risk vaulting ourselves into a new dark age much like the old, without any way to assess the truth conditions of various modal principles.

By and large, if we use a semantics to model metaphysical modality, we want it to be seemingly correct.[5] There's something intuitive about the definitions of necessity and possibility within possible worlds semantics. It seems right to say that something is metaphysically necessary just in case it happens no matter what, no matter which way the world could have been. Those who share this feeling won't want an alternative semantics to imply otherwise, even if they want to define the modal notions differently. But we also don't want an alternative semantics to imply that what's seemingly impossible is actually possible or that what's seemingly possible is actually impossible. And possible worlds semantics as such doesn't seem to have either problem. What should we do, then, when a rival modal semantics conflicts with some firmly held modal opinion? Some will say: "sayonara, semantics." Others—usually defenders of the semantics—will suggest that our modal opinions shouldn't bear so much weight since they tread on thin enough ice already. We will confront a dilemma like this in the next section.

Possible worlds semantics is widely applicable, formally flexible, and, in some sense, seemingly correct. Over the next two sections, I will evaluate three different rivals to see whether, and to what extent, they share these features.

[4] See Goldblatt 'Mathematical Modal Logic' for the history of modal logic.

[5] Vetter, (*Potentiality*, 15-16) places three constraints on any theory of metaphysical modality, and these three are fairly similar to the three putative virtues I've discussed in this section.

3 Aristotelian Rivals

We will look at two different families of rivals to possible worlds. The first family traces possibilities to the powerful properties of actual individuals. Something is possible just in case something has a power, disposition, or potentiality to bring it about. Consider the possibility that my cup breaks, for example. That possibility supposedly consists in my cup's having the property of being breakable—a power, disposition, or potentiality to break. I'll call views of this sort *Aristotelian* since they posit powerful properties with causal features. These views are often Aristotelian in another sense, since they typically disallow non-exemplified properties.

There are roughly three kinds of Aristotelian approaches to modality. Borghini and Williams ('A Dispositional Theory of Possibility'), for example, develop a more metaphysical approach which isn't meant to rival possible worlds semantics. Mondadori and Morton ('Modal Realism') and Barbara Vetter ("Can' Without Possible Worlds') offer semantic approaches to portions of natural language. Finally, there are Aristotelian rivals to the possible worlds semantics for modal logic, which will be my focus here. Recent Aristotelian rivals include the powers account of Jonathan Jacobs ('A Powers Theory of Modality') and Vetter's potentiality semantics (*Potentiality*). I'll briefly survey and evaluate each view with respect to formal flexibility and seeming correctness. I'll save a discussion about applicability until the next section.[6]

Jacobs's Powers Semantics

Jacobs offers his modal semantics in two steps. The first step embeds tautologies within counterfactuals to define the modal operators.[7] A tautology is a proposition whose truth hangs entirely on its logical form and not at all on worldly events. A proposition of the form ϕ *or not-*ϕ, for example, is tautologous because it will be true whether ϕ is true (dogs bark or it isn't the case that dogs bark) or false (pigs fly or it isn't the case that pigs fly). Either way, one disjunct is true, which makes the entire disjunction true. Counterfactuals are statements of the form *if it were the case that* ϕ*, then it would have been the case that* ψ. (I'll write $\phi \ \Box\!\!\rightarrow \psi$ for such a counterfactual.) True counterfactuals tell us what would have happened if the world had gone this way or that.

In this first step, Jacobs defines necessity and possibility in terms of what would or wouldn't be the case if some arbitrary tautology $\top$ were the case:

(JN) $\Box\phi =_{def.} \top \ \Box\!\!\rightarrow \phi$

(JP) $\Diamond\phi =_{def.} \neg(\top \ \Box\!\!\rightarrow \neg\phi)$

(JN) says that ϕ's necessity consists in the fact that ϕ would have been true if some tautology were true. But a tautology is true no matter what or true if anything is. So we can also understand (JN) more informally to say that ϕ's necessity consists in the fact that ϕ would be true if anything were true. A

[6] For broader discussions of Aristotelian approaches to modality see Jacobs ('A Powers Theory of Modality', 235-238) and Vetter ('Recent Work: Modality Without Possible Worlds', 748-753).

[7] Timothy Williamson does something similar in the first appendix to *The Philosophy of Philosophy*.

similarly informal gloss for (JP) says that ϕ's possibility consists in the fact that $\neg\phi$ would not be true automatically if just anything were true.

In step two, Jacobs offers a powers semantics for counterfactuals. The main idea is that in a counterfactual $\phi \mathrel{\square\!\!\rightarrow} \psi$, the antecedent ϕ and the consequent ψ each pick out a property complex. And the counterfactual is true just in case the antecedent's property complex is a power whose instantiation guarantees the instantiation of the consequent's property complex. To illustrate the view, take the counterfactual that my mug would break if I were to drop it on the floor. The counterfactual is true just in case the property complex in the antecedent (which would include all the specific features of the mug and the floor, as well as the circumstances of the drop) is a power whose every exercise would result in the instantiation of the consequent's property complex, including my mug's breaking on the floor.

Having already reduced the modal operators to counterfactuals in (JN) and (JP), Jacobs's powers semantics for counterfactuals now works indirectly as a semantics for the modal operators. $\square\phi$ is true when the property complex involved in an arbitrary tautology is itself a power whose every exercise would result in the manifestation of the property complex involved in ϕ. And $\Diamond\phi$ is now true when it isn't the case that the property complex involved in an arbitrary tautology is a power whose every exercise would result in the manifestation of the property complex involved in $\neg\phi$.

Instead of digging deeper into the details of Jacobs's account, I will raise two worries. The first concerns (JN) itself. Since tautologies are true solely in virtue of their logical form, how could the property complex involved in that tautology be a power to bring about any sort of non-trivial necessity? For example, how could the property complex involved in the tautology that either my chair is black or my chair is not black be a power to instantiate the property complex involved in the necessarily true proposition that all mammals are animals? The worldly powers associated with my chair and its blackness don't seem closely enough connected to the properties of being an animal or being a mammal. But the powers associated with the tautology's logical form, if there are any, don't seem closely enough connected to the properties of being an animal or being a mammal either. Jacobs's definition of necessity in terms of counterfactuals lies in tension with his own interpretation of those very counterfactuals.[8] There is no property complex involved in an arbitrary tautology which is a power to bring about necessary truths generally.[9] But if the tautologies in (JN) and (JP) are more like formally convenient devices, perhaps we can replace them in (JN) and (JP) with something else that might make more sense from within Jacobs's powers account.

Second, it's unclear whether Jacobs's account makes sense of modal principles such as (S4) and (S5) in the sense that it provides the correct sort of truth conditions for them. Jacobs ('A Powers Theory of Modality', 245-246) borrows

[8]David Yates, 'Dispositionalism and the Modal Operators', 417-418) criticizes (JN) because 2 + 2 = 4 is necessarily true even though no power could bring it about that 2 + 2 = 4. Although Jacobs ('A Powers Theory of Modality', 240) explicitly cordons off his account from logical and mathematical truths, it's not clear whether we could extend Jacobs's account to cover those truths. Vetter (*Potentiality*, Ch. 7.7) has a clever reply to this sort of worry.

[9]Or, if you dig into the rich details of Jacobs's theory, my point is that his fourth requirement on stages and chains is metaphysically suspect ('A Powers Theory of Modality', 244).

from Williamson (*The Philosophy of Philosophy,* Appendix 1) to suggest reductions for (S4) and (S5). Below are the (S4) and (S5) principles and Jacobs's suggested reductions, with some slight but harmless modifications of my own:

Modal Principle		**Jacobs's Reduction**
(S4)	$\Box\phi \supset \Box\Box\phi$	$(\top \boxdot\!\!\rightarrow \neg\phi) \supset (\phi \boxdot\!\!\rightarrow (\top \boxdot\!\!\rightarrow \neg\psi))$
(S5)	$\Diamond\phi \supset \Box\Diamond\phi$	$(\phi \boxdot\!\!\rightarrow (\top \boxdot\!\!\rightarrow \neg\psi)) \supset ((\top \boxdot\!\!\rightarrow \neg\phi) \vee (\top \boxdot\!\!\rightarrow \neg\psi))$

Notice that Jacobs disconnects his translations of (S4) and (S5) from his own definitions of necessity and possibility. Consider (S4), for example. According to Jacobs ('A Powers Theory of Modality', 246), (S4)'s reduction says "if ϕ comes what may, then supposing that ϕ holds would lead to any other proposition failing come what may." But if $\Box\phi$ is true when ϕ would be the case if anything were true, by a single application of (JN), why wouldn't we also use a double dose of (JN) to treat both boxes of the consequent in $\Box\Box\phi$? Let's try it. One: $\Box\Box\phi$ is true when $\Box\phi$ would be the case if anything were true. Two: it's true that $\Box\phi$ would be the case if anything were true when, if anything were true, it would be the case that, if anything were true, ϕ would be the case. Jacobs's account might fare better by using his very own definitions (JN) and (JP) to reduce (S4) and (S5):

Modal Principle		**Proposed Reduction**
(S4)	$\Box\phi \supset \Box\Box\phi$	$(\top \boxdot\!\!\rightarrow \phi) \supset (\top \boxdot\!\!\rightarrow (\top \boxdot\!\!\rightarrow \phi))$
(S5)	$\Diamond\phi \supset \Box\Diamond\phi$	$\neg(\top \boxdot\!\!\rightarrow \neg\phi) \supset (\top \boxdot\!\!\rightarrow \neg(\top \boxdot\!\!\rightarrow \neg\phi))$

Unlike the conditions for (S4) and (S5) that Jacobs transplants from Williamson's system, these conditions seem to follow from Jacobs's own account. Yet if (JN) is problematic because no property complex involved in an arbitrary tautology is a power to bring about necessary truths generally, then the new condition for (S4) is doubly problematic since it follows from a double dose of (JN).

Jacobs's account needs a proposition to play the role of the arbitrary tautology in (JN) that avoids the problems which arise when an arbitrary tautology plays that role. So to amend Jacobs's account, we would need a proposition which (i) is true no matter what else is true, and (ii) picks out a property complex whose every exercise would bring about necessary truths generally. The proposition that the world exists is a plausible candidate. No matter what else happens, there would be a world. And the property complex involved in there being a world of any kind might be the sort whose every exercise would bring about necessary truths generally. If we replace tautologies with the proposition W that there is a world, we can amend (JN) as follows:

(JN*) $\Box\phi =_{def.} W \boxdot\!\!\rightarrow \phi$

(JN*) says that ϕ is necessary when every exercise of the property complex involved in there being a world would bring about the property complex involved in ϕ. Whether this amended account succeeds depends on whether there is something like a very powerful property of being a world in general. This is an

interesting question, but I lack the space here to tackle it.[10] If (JN*) is defensible, we could use it to define possibility and then provide a set of amended conditions for modal principles from (K) to (S5) along the lines of those I offered for (S4) and (S5) above (but where 'W' would replace every occurrence of '$\top$'). In any case, there's more interesting and original work to be done.

Vetter's Potentiality Semantics

Barbara Vetter (*Potentiality*) builds an alternative semantics for modal logic around the notion of *potentiality*. For Vetter, potentialities comprise a wider class of properties than what we would ordinarily call dispositions. Fragility is a common example of a disposition, but it differs importantly from the potentiality to break. Fragile things (glasses, vases, etc.) have a potential to break; but many things have a potential to break (bricks, rocks, etc.) which we wouldn't ordinarily call fragile. Vetter argues that possibilities ultimately boil down to the potentialities of actual objects. And she offers a detailed potentiality semantics to cover the various modal principles.

Some potentialities are potentialities to have other potentialities. For example, water doesn't have a potentiality to break. But it does have the potential to freeze, and frozen water has the potentiality to break. So water does have a potentiality to have the potentiality to break. Vetter calls these potentialities for something to have potentialities for something to have potentialities ..., and so on, *iterated* potentialities (*Potentiality*, 135-143). Iterated potentialities account for possibility generally: Vetter (*Potentiality*, Ch. 6) says that a proposition ϕ is possible just in case something has an iterated potentiality for it to be the case that ϕ. To illustrate, consider the proposition that Mitt Romney is the 45th US President. It is possible that Mitt Romney is the 45th US President just in case something had an iterated potentiality for it to be the case that Mitt Romney is the 45th US President.

Vetter calls the "something" which has the iterated potentiality a *witness* (*Potentiality*, 198-199). In the present case, Mitt Romney is such a witness: he and the electorate together had an iterated joint potentiality to elect him in 2012. On Vetter's account of potentiality, witnesses are a dime a dozen—many witnesses have very extrinsic iterated potentialities for it to be the case that Romney wins. By just sitting there, lots of rocks had iterated potentialities for it to be the case that Romney wins, mostly because other things, including Romney, had more intrinsic potentialities to account for his possible win. Insofar as Vetter's account concerns us, there's no such thing as too many witnesses for a possibility. What would be problematic is too few—i.e., a possibly true proposition ϕ and nothing with an iterated potentiality for it to be the case that ϕ. We will soon consider the worry that there are too few witnesses.

Before we assess Vetter's account, it will be helpful to adopt her own symbolism and provide a more precise summary of her views. She expresses the above principle about possibility as iterated potentiality as follows:

(VP) $\Diamond\phi =_{def.} \exists$xPOT*[$\phi$](x) (for x the first variable not free in ϕ).

[10] Vetter (*Potentiality*, Ch. 7.3) discusses a similar question in relation to her own account. And the suggestion bears interesting similarities to my semantics ('Modal Intensionalism') and its reliance on the property of being a world in general. I discuss my semantics in Section 4.

The main ingredient, POT*, is a sentence operator which, when appended to [ϕ](x), says that x has an iterated potentiality for ϕ. So (VP) identifies ϕ's possibility with something's iterated potentiality for it to be the case that ϕ. Vetter (*Potentiality*, 203) also informally provides a definition of necessity (using (VP) and the equivalence of $\neg\Diamond\neg\phi$ and $\Box\phi$): a proposition ϕ is necessarily true just in case nothing has an iterated potentiality for it to be the case that not-ϕ. More formally:

(VN) $\Box\phi =_{def.} \neg\exists$xPOT*[$\neg\phi$](x) (for x the first variable not free in ϕ).

Consider a presumably necessarily true proposition such as that 2 + 2 = 4. It is necessary just in case nothing has an iterated potentiality for it to be the case that 2 and 2 do not equal 4. Intuitively, nothing has such an iterated potentiality, so (VP) seems to get the right result.

For Vetter, various conditions on iterated potentiality comprise the truth conditions for various modal principles. The table below presents for each of a few well-known modal principles, a corresponding condition on iterated potentiality:[11]

Modal Principle	**Potentiality Condition**
(T) $\Box\phi \supset \phi$	$\neg\exists$xPOT*[$\neg\phi$](x) $\rightarrow \phi$
(S4) $\Box\phi \supset \Box\Box\phi$	$\neg\exists$xPOT*[$\neg\phi$](x) $\rightarrow \neg\exists$yPOT*[$\exists$xPOT*[$\neg\phi$](x)](y)
(S5) $\Diamond\phi \supset \Box\Diamond\phi$	$\exists$xPOT*[ϕ](x) $\rightarrow \neg\exists$yPOT*[$\neg\exists$xPOT*[ϕ](x)](y)

Below, I translate each condition into English. And beside each condition's antecedent and consequent, I provide the metaphysical equivalent in parentheses, via Vetter's semantics. Happily, these parenthetic equivalents perfectly match the antecedent and consequent of each corresponding modal principle.

(T) If nothing has an iterated potentiality for it to be the case that $\neg\phi$ (i.e., if ϕ is necessary), then ϕ is the case.

(S4) If nothing has an iterated potentiality for it to be the case that $\neg\phi$ (i.e., if $\neg\phi$ is not possible—if ϕ is necessary, in other words), then nothing has an iterated potentiality for it to be the case that something has an iterated potentiality for it to be the case that $\neg\phi$ (i.e., it is impossible that it is possible that $\neg\phi$—in other words, ϕ is necessarily necessary).

(S5) If something has an iterated potentiality for it to be the case that ϕ (i.e., if ϕ is possible), then nothing has an iterated potentiality for it to be the case that nothing has an iterated potentiality for it to be the case that ϕ (i.e., it is impossible that it is impossible that ϕ—ϕ is necessarily possible, in other words).

Vetter's semantics would have to cover other modal principles as well, but I believe the formal flexibility of the semantics will survive close scrutiny when it's used for metaphysical modality.

[11] Vetter (*Potentiality*, 210-212) uses the less traditional but equivalent formulations of (T) and (S4) with possibility operators only. I use the more traditional formulations here, not only because they are more traditional, but also because it's important to show that Vetter's semantics can handle them just as easily.

However, it's less clear whether Vetter's account is seemingly correct. Many actual things are contingent beings—they could have failed to exist. A potentiality theorist might hope to explain each contingent being's possible non-existence by appealing to its causal history: each contingent being sits at the end of some causal history, and something in that history had a potentiality whose manifestation would have resulted in the contingent being's non-existence. But Ross Cameron ('Truthmakers and Modality', 273) argues that Aristotelian views cannot apply that explanation to account for more global contingencies:

> But what about the highly intuitive possibility that *none* of the actual contingently existing substances existed—what is the truthmaker for the truth that this situation is possible? It can't be any of the actual contingently existing beings, for none of these beings has the capacity to bring it about that it itself *never existed*. And there are other possibilities that the Aristotelian account looks hard pushed to ground, such as the possibility of there being different global laws of nature, or in general possibilities concerning how the world could have been globally.

Cameron's concern goes beyond Vetter's account to all sorts of Aristotelian accounts of modality. Unless the Aristotelian rejects Cameron's concern as somehow misguided, she will have to point to some necessary being(s) whose power(s) could explain these global contingencies.[12] But what sort of necessary being(s) had the power to bring about different laws of nature or a different crew of contingent beings?

Alexander Pruss ('The Actual and the Possible'; *Actuality, Possibility, and Worlds*) and Jonathan Jacobs ('A Powers Theory of Modality', 238) both posit a Big Bopper, a non-material necessary being with the potentiality to create all sorts of universes.[13] Vetter opts for more mundane necessary beings. Given that there was nothing before the first moment in time, and so nothing with any potentiality for anything, Vetter (*Potentiality*, 273-277) tentatively concludes that the first event in time occurs necessarily. Whatever exists in the first event, exists necessarily, and the potentialities embedded in the first event explain the contingency of any contingent beings that ever exist. This response counterintuitively implies that some concrete objects exist necessarily.[14] But maybe that's not a big deal.

What should we do when a pre-theoretical modal intuition conflicts with a proposed theory of modality? We could take these surprising consequences as evidence against the theory which implies them. Even if we do, I hope we can continue to develop the theory systematically alongside other competing theories. Perhaps when future metaphysicians have finally worked out the

[12]Gabriele Contessa, for example, doubts whether it's possible for none of the actual contingent beings to have existed ('Modal Truthmakers and Two Varieties of Actualism', 342-346). Borghini and Williams ('A Dispositional Theory of Possibility', 37-38) respond similarly, but not directly to Cameron.

[13]Cameron ('Truthmaker's and Modality', 273-276) argues that the Pruss-Jacobs response is subject to a sort of Euthyphro dilemma and makes hash of modal epistemology.

[14]For recent discussion on this and related points, see Jennifer Wang, 'The Modal Limits of Dispositionalism', David Yates, 'Dispositionalism and the Modal Operators', and especially Vetter, *Potentiality*, 257-263, 282-300.

Table of Systematic Metaphysical Theories, the majority will have good reason to lessen their confidence in the original intuition. We don't know that they won't, and that's some reason not to wield our pre-theoretical modal intuitions as theory killers.

4 Platonic Rivals

The final difficulties mentioned in the previous section result from trying to pin modality down to actually exemplified causal properties. Perhaps we can avoid those difficulties with a different account of properties. I'll call views *Platonic* when they appeal to non-causal properties or at least non-causal features of properties. These views are often Platonic in another sense, too, since they typically permit non-exemplified properties.[15]

Which non-causal properties or which non-causal features of properties? Kit Fine ('Essence and Modality', 'Semantics for the Logic of Essence') and Fabrice Correia ('Generic Essence, Objectual Essence, and Modality') appeal to the essences of things or their properties to explain why they're necessarily so-and-so. But it's unclear whether Fine or Correia could flesh out a semantics without possible worlds. (Fine especially relies heavily on them.) Michael Jubien ('Analyzing Modality', *Possibility*) argues that Fs are Gs necessarily because the property F *entails* the property G. Tony Roy ('Worlds and Modality') argues that Fs are Gs necessarily because the property of being F is a *disjunctive constituent* of the property of being G. These latter two approaches lack the formal detail to ground a rival semantics. More recently, I ('Modal Intensionalism') have used a property parthood relation in a new semantics for modal propositional logic. I'll briefly evaluate my own semantics and then pick up the promised discussion on applicability for all three views.[16]

Sometimes we say things like "being an animal is part of being a mammal." If being an animal is part of what it means or part of what it takes for something to be a mammal, then nothing could exemplify the whole (*being a mammal*) without also exemplifying the part (*being an animal*). For if the property of being an animal in general is part of the property of being a mammal in general, then anything which exemplifies the property of being a mammal must also exemplify its parts, including the property of being an animal. I've shown that if we take this way of speaking seriously, we can account for modal truths generally, at least in modal propositional logic.

The property of being our world, alpha, is to the property of being a world in general as the property of being Obama is to the property of being a mammal in general. We can think of each pair as something like a determinate and determinable. I use the property of being alpha (written $\mathcal{A}$) to define truth and the property of being a world (written $\mathcal{W}$) to define necessary truth. A proposition ϕ is true when the propositional property of being such that ϕ

[15] In this second sense of Platonism, some have endorsed Platonic views of dispositions, which means that they endorse properties which are both Aristotelian in some sense (since they are causal) and Platonic in some sense (since they are possibly unexemplified). See Matthew Tugby ('Platonic Dispositionalism') for a defense of such a view and further references.

[16] For broader discussions of Platonic approaches to modality, see Jacobs ('A Powers Theory of Modality', 234-235) and Vetter ('Recent Work: Modality Without Possible Worlds', 744-747).

(written $[\phi]$) is part of $\mathcal{A}$.[17] For example, 'Votto plays baseball' is true just in case *being such that Votto plays baseball* is part of $\mathcal{A}$. And ϕ is necessarily true when $[\phi]$ is part of $\mathcal{W}$:

(WN) $\Box\phi =_{def.}$ $[\phi]$ is part of $\mathcal{W}$

The proposition that 2 + 2 = 4 is necessarily true, then, if and only if the propositional property of being such that 2 + 2 = 4 is part of the property of being a world in general. I ('Modal Intensionalism', 331) argue that (WN) would help explain why some truths are true in all possible worlds.[18] Any possible world, had it been actual, would have been a world and exemplified the property of being a world in general. But nothing can exemplify the property of being a world without exemplifying its parts. Therefore, if a propositional property such as *being such that 2 + 2 = 4* is part of $\mathcal{W}$, then any possible world would have exemplified *being such that 2 + 2 = 4* if it had been actual.[19] Using (WN) and the equivalence of $\neg\Box\neg\phi$ and $\Diamond\phi$), I also define possibility in relation to $\mathcal{W}$:

(WP) $\Diamond\phi =_{def.}$ $[\neg\phi]$ is not part of $\mathcal{W}$

The proposition that Gia is a dog, for example, is possible just in case *being such that it isn't the case that Gia is a dog* is not part of $\mathcal{W}$. Possible truths, then, correspond to propositional properties which $\mathcal{W}$ does not preclude.

(WN) and (WP) together provide the truth conditions for various modal principles. Each principle's truth depends on whether certain properties have certain other properties as parts. The table below presents for each of a few well-known modal principles, a corresponding condition on property parthood. (In the table, $<$ should read "is part of" and $\not<$ "is not part of.")

Modal Principle	**Parthood Condition**
(T) $\Box\phi \supset \phi$	$[\phi] < \mathcal{W} \rightarrow [\phi] < \mathcal{A}$
(S4) $\Box\phi \supset \Box\Box\phi$	$[\phi] < \mathcal{W} \rightarrow [[\phi] < \mathcal{W}] < \mathcal{W}$
(S5) $\Diamond\phi \supset \Box\Diamond\phi$	$[\neg\phi] \not< \mathcal{W} \rightarrow [[\neg\phi] \not< \mathcal{W}] < \mathcal{W}$

Let's pause to digest these conditions. (T) is true when any propositional property which is part of $\mathcal{W}$, is also part of $\mathcal{A}$. If being a world is part of being this world in particular, which seems reasonable, then as long as parthood is

[17] Theorem 20 in Edward Zalta's 'Twenty-five Basic Theorems of Situation and World Theory' says something similar.

[18] Michael Jubien (*Possibility*, 75) argues that we cannot explain from possible worlds alone why some truths appear in all possible worlds.

[19] There are two important differences between my semantics and the view of Robert Stalnaker ('Possible Worlds') that possible worlds are possible properties of the actual world. First, Stalnaker and I characterize necessary or possible truth differently. Stalnaker doesn't use a property like the property of being a world in general to define necessary and possible truth. This property isn't complete or large enough to count as a possible world on anyone's conception of possible worlds. Yet this property is enough to define necessity and possibility in my semantics. Second, propositional properties are parts of properties like *being a world* and *being alpha* on my view whereas Stalnaker does something like the converse and defines propositions as sets of primitive possible worlds. My view of propositional properties allows for them to be distinct but necessarily coextensive. Stalnaker's view of propositions implies that necessarily coextensive propositions are identical.

transitive, which is also reasonable, (T) will be true. The conditions for (S4) and (S5) are more complicated, however. In each one, some propositional property is embedded in another propositional property. The condition for (S4): if $[\phi]$ is part of $\mathcal{W}$, then being such that $[\phi]$ is part of $\mathcal{W}$ is also part of $\mathcal{W}$. Given (WN), this is another way of saying that if ϕ is necessary, its necessity is necessary. The condition for (S5): if $[\neg\phi]$ isn't part of $\mathcal{W}$, then being such that $[\neg\phi]$ isn't part of $\mathcal{W}$ is itself part of $\mathcal{W}$. Given both (WN) and (WP), this is another way of saying that if ϕ is possible, it is necessarily possible. I believe that my semantics for modal propositional logic is as formally flexible as possible worlds semantics even though, as I admit, there is still some formal work undone.[20]

Compared to the Aristotelian rivals I've surveyed, the intended interpretation of my semantics is admittedly underdeveloped, metaphysically speaking. But this is by design. I leave open what properties really are, metaphysically speaking, to display "the loosely interpreted formal features of [my view], similar to the way one might explain the loosely interpreted ins and outs of possible worlds semantics" ('Modal Intensionalism', 315). I charitably interpret myself as setting the formal parameters for a new non-possible worlds semantics for modal propositional logic which treats intensionality as more basic than modality. However, this makes judging the seeming correctness of the semantics fairly difficult, if not impossible. For example, what does it really mean for a property to be part of another? I ('Modal Intensionalism', 316-323) reject some possible answers and ultimately hint at a conjunctive analysis of parthood according to which being F is part of being G when being G is a conjunction of properties, one of which is being F ('Modal Intensionalism', 318 n. 26). But different accounts of properties make more or less sense of the view that they're generally conjunctive. And some seemingly correct modal judgments may mesh better or worse with different accounts of conjunctive properties. We will have to relativize judgments about the seeming correctness of my semantics to the various ways we can fill in its metaphysical details.

Furthermore, Jacobs and Vetter offer a compelling story about modal knowledge that seems unavailable to me. Dispositions (or powers or potentialities or whatever we call them) actually manifest themselves in both ordinary and scientific contexts, and we have good reason to attribute them to things even when we fail to observe their manifestations. But Platonic properties succumb to Benacerraf-style worries about our knowledge of abstract objects.[21] Platonic properties aren't located in space or time, and we've never laid eyes or fingers on them. The challenge is to explain how our cognitive periscopes could break through the concrete underworld of chairs and tables into the abstract realm to provide us knowledge of Platonic properties. There's simply no easy answer.[22]

In spite of these difficulties, my semantics does seem applicable to a wider set of modalities. Like possible worlds semantics, we can understand the formalism differently to model different kinds of modal discourse. Whereas in possible worlds semantics, we restrict ourselves to smaller sets of possible worlds (the

[20]See ('Modal Intensionalism', 323-331) for my explanation of how these and other conditions on property parthood work in the semantics.

[21]See Benacerraf 'Mathematical Truth'. Jason Turner ('Possibility, by Michael Jubien', 184) lodges a similar complaint against Jubien.

[22]For a recent explanation of the problem, see Justin Clarke-Doane's 'What is the Benaceraff Problem?'.

morally ideal worlds, e.g.), in my semantics we can use "larger" properties than the property of being a world in general (the property of being a morally ideal world, e.g.). If property parthood is analyzed conjunctively, we can think of *being a morally ideal world* as the conjunctive property of being a world in general and being morally ideal. Adding this second conjunct to $\mathcal{W}$ accomplishes for my semantics what quantifier restriction accomplishes in possible worlds semantics. We can then use the property of being a morally ideal world to define what is obligatory: it is obligatory that rich people give to charity if and only if the propositional property of being such that rich people give to charity is part of the property of being a morally ideal world.[23] Whether Jacobs's powers semantics or Vetter's potentiality semantics could account for the logic of obligation is less clear to me. I simply don't know how to link powers or potentialities to what we ought morally to do.[24]

Even if my semantics can apply more widely than Jacobs's or Vetter's, none can claim that our formalism applies as widely (or as elegantly) as possible worlds semantics. But depending on our purposes, perhaps we shouldn't want a semantics to apply so widely. What we know and what we ought to do seem very different from each other and from what's metaphysically necessary.[25] We likely wouldn't have expected to treat all three similarly unless a relatively successful semantics had already done so. Perhaps possible worlds semantics can treat the different modalities similarly partly because it misses something crucial and explanatory in its application to each. For example, each of the rivals surveyed has the resources to explain why truth-values are distributed as they are among metaphysically possible worlds.[26] So perhaps there is a trade-off between the explanatory power of a modal semantics and its formal ability to apply to other modalities.

These considerations might suggest that the Platonic and Aristotelian rivals aren't really *rivals* to possible worlds semantics. I'm not convinced they are even rivals with one another. (Arguably, concepts are the intensional entities best suited for my semantics, and the world has enough room for both concepts and potentialities.) Each semantic theory may capture a different aspect of modal reality or different aspects of the linguistic or conceptual resources we use to theorize about it. If that's right, then we can treat the various rivals surveyed here as parallel train tracks carrying different loads to different locations and with their own unique challenges. This gives us the freedom to hop around from track to track, fixing problems as we see fit.

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[23] In 'A New Semantics for a New Deontic Logic', I also amend this account to ensure that not all tautologies are obligatory.

[24] Though see Vetter's discussion of deontic and epistemic senses of 'can' ("Can' without Possible Worlds', 23-25; *Potentiality*, 232-246).

[25] See Vetter, *Possibility*, Section 6.9.2 and Viebahn and Vetter, 'How many meanings for 'may'?', Section 5.

[26] See, for example, Vetter, *Possibility*, Section 7.4, and also Warmke, 'Modal Intensionalism', Section 9, where I argue that my semantics has this explanatory value.

5 Conclusion

Possible worlds semantics is widely applicable to different modal notions and formally flexible in the way it accounts for the truth of different modal principles. It also characterizes metaphysical necessity and possibility in a seemingly correct way. Even if the theories I've surveyed characterize the modal notions better along some dimension, none can boast the formal power or flexibility of possible worlds semantics. But that just means that the work is partially done. Future metaphysicians will someday have an Aristotelian or Platonic modal semantics which compares favorably to possible worlds semantics. Between now and then, we will have to make both formal and metaphysical progress. Formally, someone will have to develop a semantics for quantified modal logic (modal logic equipped with names, predicate letters, and quantifiers) which is as at least as formally flexible as the possible worlds approach to quantified modal logic. Metaphysically, someone will have to provide a seemingly correct metaphysical interpretation of the semantics which explains both how properties ground modal reality, on the one hand, and how they provide us modal knowledge, on the other.

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