Counterparts and Counterpossibles:  
Impossibilities without Impossible Worlds

Abstract
Standard accounts of counterfactuals with metaphysically impossible antecedents take them to be trivially true. But recent work shows that nontrivial countermetaphysicals are frequently appealed to in scientific modelling, and are indispensable for a number of metaphysical projects.

Here, I’ll focus on three recent discussions of counterpossible counterfactuals. First, Peter Tan (2019) has argued that many cases of scientific explanation and theory evaluation require counterpossible conditionals. Second, Wilson (2016) has argued that grounding explanations require counterpossibles to explicate dependence relations. Finally, Bhogal (Forthcoming) has argued that Humeans should regard simple worlds with complex laws worlds as scientifically possible but metaphysically impossible. I’ll argue that other views of lawhood, including dispositional essentialism and nomic necessitarianism, face similar problems.

I will show that a sufficiently developed counterpart theory can provide a semantics for a wide range of counterpossibles without any inconsistent possibilities. But such a view faces problems: in order for the metaphysical views I discuss to bear weight, there must be a significant difference between the metaphysical possibilities and impossibilities. I will show how the counterpart theoretic view delineates the possible from impossible, while still making room for the impossible.

Introduction

What would happen if water had a different molecular structure? Since water is essentially $H_2O$, this question invites countermetaphysical supposition: it is metaphysically impossible for water to have had a different molecular structure. There’s a tradition going back to Lewis (1973) of taking countermetaphysical conditionals like these to be trivial. But that tradition is under increasing pressure.

Here, I’ll review three recent discussions of counterpossible counterfactuals. First, Tan (2019) has argued that many cases of scientific modelling require counterpossible conditionals. Some of Tan’s examples are cases in which properties are counterfactually considered to behave in ways in which they couldn’t possibly behave. Second, grounding theorists who see metaphysically explanations as structurally similar to causal explanations need counterpossibles
to explicate grounding-dependence relations. Third, Humeans hold that laws 
metaphysically supervene on particular matters of fact. But many authors have 
pointed out that we can counterfactually consider what the same situation 
would be like under multiple incompatible scientific laws. If the Humean is 
correct, these are counterpossible suppositions. I’ll examine these cases in more 
detail in my opening §1.

These three examples of counterpossible counterfactuals have a unifying 
feature: properties which are grounded or nonfundamental in the actual world 
either have a different grounding base in a merely possible world, or are un- 
grounded in that world. I’ll present a model of possible worlds on which a 
fundamental property in one world can be nonfundamental in another. This 
model is a version of property counterpart theory; whether a property at one 
world is the same property as a property at another world depends on a coun- 
terpart relation. I’ll discuss this solution in §2 and In §2.2 I directly address 
the problem cases. In the interest of brevity I leave a detailed discussion of the 
counterpart-theoretic semantics to the appendix.

But counterpart theory can’t get us out of the woods on its own. For the 
views above to carry philosophical water, there must be a meaningful dis- 
tinction between metaphysical possibility and impossibility. I’ll propose two 
strategies to deal with this issue. The first strategy, which I call “grafting”, adds 
a counterpart relation to any already developed account of possible worlds, 
and will appeal to philosophers with well developed theories of metaphysical 
possibility. The second strategy, which I dub “legislating”, identifies some coun- 
terpart relations as metaphysical and others as impossible; this strategy fits well 
with certain conventionalist or law-based approaches to metaphysical possibil- 
ity. I’ll outline these strategies in §3. I’ll then argue that a counterpart theoretic 
approach provides the basis for compelling responses to arguments for coun- 
terpossible triviality found in Williamson (2018), Williamson (2007), and Vetter 
(2016).

Finally, in §4 I discuss whether this approach creates new problems for 
actualist or ersatzist views of possibilia. My focus here is on countermetaphys- 
cal counterfactuals. I take no stance on whether this strategy can be extended 
to other counterpossibles, including countermathematicals or counterlogicals. 
With that caveat in place, I will now explicate the problem cases.

1 Three Uses for Counterpossibles

Standard semantics for counterfactuals take a counterfactuals $A \rightarrow B$ to be 
true if and only if the consequent $(B)$ is true at every closest possible world at 
which the antecedent $(A)$ is true. Closeness is typically understood as a sort of 
similarity: in evaluating the counterfactual, we ask what the world would be
like if it were changed as little as possible to accommodate the antecedent. If $A$ is impossible, then there is no $A$-world and so no closest $A$ world. Trivially, then, the consequent is true at every closest $A$ world and the counterfactual is trivially true.

There is a general view that this is not a problem. Ordinary counterfactuals are appealed to by philosophers in accounts of evidence, inference, explanation, and decision-making. Since the antecedents of counterpossibles can’t happen, they don’t seem relevant to explanation, decision theory, or accounts of knowledge and evidence. Their triviality doesn’t seem to challenge any philosophical project. Recently, though, a number of interesting applications of counterpossible reasoning have cropped up. I’ll look over three below.

A traditional response to these examples has been to take the counterfactuals to be trivial and explain their apparent nontrivial truth (or falsity) away via a combination of conversational pragmatics and the unsophisticated metaphysical intuitions of the folk (who in this case are scientific researchers) (see for example Emery and Hill (2017), Williamson (2018), Williamson (2007, pp. 171-5)). In each of these cases, I’ll discuss what I take to be the costs of the error theory: by treating taking these counterfactuals to be trivial we lose significant epistemic handles on the actual world.

1.1 Nontrivial Scientific Impossibilities

Scientific modelling often requires us to idealize away features of the actual world we don’t want to focus on, or consider simplified counterfactual models in which systems have properties they are known not to have. Such models are useful for a variety of reasons: they enable us to employ mathematical methods that are well-understood and come up with solutions that match those in the actual world, and they allow us to focus on the features of the actual system that matter for our explanatory or predictive purposes without being distracted by those features which do not. Additionally, they enable us to discern which of a system’s features are relevant to explaining its causal or structural properties. Tan (2019) considers a variety of such counterfactuals, and argues compellingly that these counterfactuals have impossible antecedents but are nonetheless scientifically interesting, and nonvacuous. Tan considers counterfactuals whose antecedents are impossible because they violate the essential nature of nonfundamental kinds, such as

\[ W: \text{If water were a continuous, incompressible medium, then it would behave as the Navier-Stokes equations describe. In other words, the wave behavior of actual water closely approximates how water would behave, if it really were continuous. When put to their proper purpose, these models are quite successful...} \] (Tan, 2019: p. 46).

There is, of course, much to be said about how possibilities manage to be closer than one another—but I need not say that here.
These examples put pressure on the idea that counterfactuals ought to be evaluated with respect to metaphysical possibilities. To accommodate them, we should consider scientific possibilities that are metaphysical impossibilities. I’d like to highlight Tan’s claim that the behavior of actual water closely approximates that of an incompressible fluid. This similarity of behavior will be a key component of my positive view: the incompressible fluid is a counterpart of water just because its behavior is similar.

Tan’s example isn’t isolated; for similar examples see McLoone (forthcoming) and Jenny (2018). Things become more complicated on some theories about natural lawhood; for example, dispositionalists of the stripe of Bird (2007) or Vetter (2016) take properties to have fairly fragile modal profiles: any change to Coulomb’s constant, for example, would result in a world without charge (that world would instead have a completely different charge-like property). On such views, idealizations which involve even slight counterfactual changes to the laws governing, say, an electron are counterpossibles, at least insofar as they are counterfactual suppositions about particular particles or actual particles generally.

Why do scientific models make impossible idealizing assumptions? And can we accommodate those uses without nontrivial counterpossibles? I doubt it. As Bokulich (2011) points out, fictional and idealized models are often explanatory. On Bokulich’s view these models are explanatory because they mirror the counterfactual dependencies that exist in the systems they represent. But many of the fictions and approximations Bokulich considers (such as the Bohr atom or frictionless planes, continuous fluids, or zero-dimensional point particles) are metaphysically impossible ways for the target system to be. If countermetaphysicals like W are trivial, these models cannot both represent their target system and mirror that system’s counterfactuals dependencies. But if Bokulich is right, counterpossible triviality leaves fictional and idealized models unexplanatory.

Similarly, Bhogal (Forthcoming), Tan (2019), and Loew and Jaag (2020) all note that by examining counterpossible counterfactual worlds we gain information about the role necessarily conjoined influences play in the actual world. So when we consider how something would act if there wasn’t air resistance or friction, we can thereby evaluate what role air resistance and friction when making predictions in the actual world, and figure out when it can safely be ignored. Because we consider how water would behave were it continuous, we can attribute the ways in which its behavior diverges from the idealization to its

3In response to this, one could relax the widely accepted constraint that the model should represent the target system. In some cases this would render the relevant counterfactuals metaphysically possible. But it would deeply complicate our understanding of model explanations; without the representational constrain, we would have difficulty delineating the target of a model, so nearly anything could count as a model of anything else. It would be quite difficult to explain why models are explanatory of some systems and not others.

Things are slightly complicated by views of model-representation like Frigg and Nguyen (2017) which denies that all features of the model represent the target system. Nonetheless, the model system has its own counterfactual structure; insofar as the antecedents of these counterfactuals are impossible, the counterfactuals involved are counterpossible.
molecular structure. If these counterpossibles were trivial, then they would not give us any useful information about the behavior or counterfactual structure of the target system in the actual world.

1.2 Grounding and Nontrivial Counterpossibles

Wilson (2016) and Schaffer (2016) both argue that grounding should be modelled using the structural equations framework, which enjoys increasing success in accounting for causal phenomena. In causal models, these equations are taken to represent counterfactual dependencies: if my model connects a variable $R$, representing the throwing of a rock, to a variable $B$, representing the breaking of a window, the framework interprets this to mean that if the rock had not been thrown, the window would not have broken. Or more precisely, if an intervention had set the value of $R$ to $\neg r$, representing that the rock is not thrown, then the value of $B$ would have been $\neg b$, indicating that the window did not break. These dependencies are often represented using directed acyclic graphs (DAGs), in which points represent the variables and edges connect variables which directly depend on one another according to the relevant set of structural equations.

Wilson and Schaffer argue that we should extend this framework to understand non-causal dependence relations. Because the structural equations framework models rely on counterfactual dependence relations, and since non-causal dependence concerns not just the way things are, but also the way things must be, Schaffer and Wilson argue that this requires some counterfactuals with metaphysically impossible antecedents to be true, and others to be false. For example Wilson considers the following two counterfactuals, dealing with Socrates and the set that contains only Socrates:

CF1. If an intervention had prevented Socrates from existing, then Singleton Socrates would not have existed. — True [...] CF3. If an intervention had prevented Singleton Socrates from existing, then Socrates would not have existed. — False

(Wilson 2016, p. 722)

On an initial reading, it’s very tempting to think that CF3 is true, rather than false. This is because, given the necessary connection between sets and their members, the closest world (in fact every world) without Singleton Socrates is a world without Socrates. But these close worlds are the wrong ones to look at, because the antecedent doesn’t just stipulate that Singleton Socrates fails to exist—it says that Singleton Socrates fails to exist because of an intervention. An intervention is defined (roughly speaking) as a change in the target variable (Singleton’s existence) that doesn’t directly change any other nodes in our grounding structure—including whether Socrates exists. So while the simplest, and only possible way, to remove Singleton is by removing Socrates, the stipulation that Singleton is intervened upon requires us to look at worlds which
change the abstract object—Singleton—without changing the concrete object—Socrates. Because this impossible intervention would, by stipulation, not alter Socrates’ existence, CF3 is false.

Taken together, these two counterfactuals show that there is an asymmetric dependence relation between Socrates and Singleton Socrates. Singleton Socrates depends on Socrates for its existence; Socrates does not depend on Singleton Socrates for his existence.

But there is simply no possible intervention which would bring about Singleton Socrates not existing, because (as Wilson defines it) such an intervention would have to “sever” any dependence relations which ground Singleton Socrates. Since Singleton Socrates is necessarily grounded by Socrates, any intervention which cuts or removes this grounding relation is metaphysically impossible.

Schaffer and Wilson argue that using interventionist counterfactuals to understand grounding has a numerous advantages. It allows us to provide a unified account of the dependence relations that back scientific and metaphysical explanation. It also allows us to use the same epistemic framework we use in scientific and causal reasoning to uncover the world’s metaphysical structure.

1.3 Humeanism in Simple Worlds

According to the standard Humean picture, the world is just a sequence of particular occurrences. This view was best expressed by Lewis: “Humean supervenience is named in honor of the greater denier of necessary connections. It is the doctrine that all there is to the world is a vast mosaic of local matters of particular fact, just one little thing and then another” (Lewis, 1986a). What are these particular matters of fact? Lewis held that they are qualitative properties instantiated at spacetime points. Recently Humeans have been open to a wider variety of fundamental properties and relations, but some things are clearly ruled out: mental properties, for example, or modal properties, such as dispositions or ungrounded counterfactuals. This leaves the Humean with a task: the Humean must give an account of modal notions, including the laws of nature, normative notions, and mental notions in terms of the spatiotemporal distribution of properties.

Humeans account for laws of nature like this: the laws summarise the matters of fact. A summary is good when it summarizes concisely, and it is good when it summarizes a lot. So, the laws should be both concise and informative. This is the Best Systems Account (BSA): the laws of nature are those generalizations which best balance simplicity and informational strength.

The problem for the Humean is that one world or situation can be modelled by different systems of laws, and considering what would happen in that situation under different systems of laws is a scientifically fruitful activity. This objection was first clearly expressed by (Carroll, 1994). Here’s an example from Tim Maudlin:

\footnote{For a view which denies that these counterfactuals need to be nontrivial, see Emmerson (MS).}
Can two different sets of laws have models with the same physical state? Indeed they can. Minkowski space-time, the space-time of Special Relativity, is a model of the field equations of General Relativity (in particular, it is a vacuum solution). So an empty Minkowski space-time is one way the world could be if it is governed by the laws of General Relativity. But is Minkowski space-time a model only of the General Relativistic laws? Of course not! One could, for example, postulate that Special Relativity is the complete and accurate account of space-time structure, and produce another theory of gravitation, which would still have the vacuum Minkowski space-time as a model. So under the assumption that no possible world can be governed both by the laws of General Relativity and by a rival theory of gravity, the total physical state of the world cannot always determine the laws. (Maudlin 2007, p. 67)

Note that there are two problems here: first, the same situation—a flat spacetime—can apparently be governed by two distinct sets of laws: either Special Relativity combined with (say) modified Newtonian gravity (hereafter (“SR + N”) or General Relativity (hereafter “GR”). This looks like a direct counterexample to Humean supervenience, as both worlds have the same occurring facts (there is an empty flat spacetime) but they have different laws, and different counterfactuals are true at each of them. Since Humean supervenience is the claim that there are no differences in laws without difference in non-nomic facts, the existence of both possibilities—at least apparently—rules it out.

Second, since the actual laws are GR even if spacetime were empty the laws of GR would still hold. Scientists might consider what would happen given interventions at such an empty world, using GR as a guide. Unfortunately, considering what counterfactuals are true at that world on the supposition that the laws there are the laws of General Relativity violates the BSA, according to which the laws would be the simplest description of the world (and SR + N is a simpler description).

Let’s call these counterfactuals SIMPLEGR:

SIMPLEGR₁: If you added a mass to an empty spacetime governed by the laws of General Relativity, that spacetime would curve.

SIMPLEGR₂: If you added a mass to an empty spacetime governed by the laws of General Relativity, that spacetime would not remain static.

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Lewis [1986a] (p. x) argued that Humean Supervenience is at best a contingent thesis. Unfortunately, this is no help to the Humean in this context. For Lewis’s examples of unHumean worlds are those with extended simples, fundamental properties of regions rather than points, and nonspatiotemporal external relations; none of these give us reason to think that unreduced laws in the sense of Bird [2007], or Maudlin [2007]. In fact it is hard to see how Lewis’s modal realism could make sense of worlds with such unreduced nomic modality. Contemporary Humeans are not modal realists but are modal reductionists, and so should not try to make sense of these worlds either.
simplegr_{1} is true and simplegr_{2} is false. But if Humeanism is true they both have a metaphysically impossible antecedent, since no empty spacetime has the laws of GR in its best system. So Humeanism seems to entail that some important nontrivial counterfactuals are countermetaphysicals.

Similar worries arise for nomic necessitarians in a wide range of circumstances. While Humeans cannot make sense of simple worlds governed by complex laws, necessitarians along the lines of Wilson (2020) don’t allow for any worlds with any laws but the actual laws. For necessitarians, all counter-nomics are counterpossibles, and so, on the standard semantics, trivially true.

Why do we care about counterfactuals concerning different laws? One answer is that doing so is a vital part of the way we confirm our actual theories. Dorst [Manuscript] notes that we often use counterfactuals to evaluate evidence for a theory. By determining what would happen if a theory were true, we can compare that counterfactual behavior to the actual behavior of physical systems. Thinking about how counterfactuals play out at some impossible world given some theory L, we can construct experiments in the actual world to test L. In this vein, nontrivial grounding counterfactuals can help us evaluate theories about what grounding relations hold, even if we take those grounding relations to be necessary if they in fact hold. In this way, the use of counterfactuals with impossible antecedents is very similar to their use in standard scientific modelling.

For example, in order to show that the progression of the perihelion of mercury is a counterexample to Newtonian gravitational theory, we first show that, if the solar system was Newtonian and only contained the sun and Mercury, the perihelion would advance 43 seconds less than it actually does. We then argue that the gravitational influence of other planets isn’t sufficient to account for this discrepancy, by showing that even if the Newtonian model included those planets, the perihelion would not progress the additional 43 arc seconds. We then conclude that these counterfactuals have a false antecedent: the actual world is not Newtonian. On Humean and necessitarian views, these are countermetaphysicals.

Giving up on these nontrivial countermetaphysicals would require us to give up on these important tools for discovering the structure of the actual world. Of course, we could apply an error theory. Since these applications of countermetaphysical reasoning are directly involved in scientific explanation, prediction, and confirmation, the error theory would be an embrace of scientific anti-realism. Meanwhile, the error theory would have to be richly structured to predict which (trivial) countermetaphysicals we find explanatory and which we don’t. It could not easily lean on our prior understanding of the actual world’s counterfactual structure, since we often use these counterpossibles to understand that counterfactual structure. Imagine such an error theory were available. Why not take it to give the truth conditions of countermetaphysicals, rather than just giving their acceptance conditions?

\footnote{Though see [Fletcher forthcoming] for an alternative model of these counterfactuals.}
2 Impossible Counterparts

I think that a properly developed property counterpart theory can handle these cases, and can do so in a way that makes sense of the idea that these are really counterpossibles. And I think this strategy has an advantage: it doesn’t require us to introduce impossible worlds of the sort in Nolan (1997), Brogaard and Salerno (2013), Bernstein (2016) or Priest (2016). For a thorough explication of first-order counterpart theory applied counteridenticals see Kocurek (2018) and Wilhelm (2020).

For this strategy to be successful requires me to complete two tasks: first, I need to show how the strategy provides worlds and counterparts for the problematic counterpossible counterfactuals. I’ll explain the model in §2.1, and give more details about the formal model in the appendix. Then, in §2.2 I’ll show how property counterpart theory handles the problem cases. To make good on the claim that these counterfactuals are counterpossibles, I need to show that these are, in a meaningful sense, impossibilities. Given that I deny that they are incomplete or contain contradictions, this is a tricky task; in §3.1 I’ll argue that some counterpart relations are metaphysically privileged, and that the metaphysical possibilities are those which correspond to these counterpart relations.

2.1 Property Counterpart Theory

The strategy I present for handling the problem cases follows Heller (1998) in employing a higher-order counterpart theory. In first-order modal counterpart theory, we take each individual to be represented at different possibilities by a modal counterpart: a stand-in who is similar in some respect to the actual individual. If I could have been a contender, it’s because there’s some possible individual who is very like me in some contextually salient way, and who contends.

Traditionally, counterpart theory has been associated with Lewis (1986b)’s thesis of modal realism. Because Lewis held that each world was as real as the actual world, he understood individuals at other worlds to be distinct from actual individuals. He therefore needed to explain how anyone has nontrivial de re modal properties. Modal counterparts filled that gap. Counterpart theory should not be tied to any particular modal metaphysics. As Wang (2015) argues, counterpart theory is useful for modal ersatzists, and Schwarz (2014) points out that counterpart theory is useful even when we accept that individuals are identical to one another in different worlds or points of evaluation. Finally, Kocurek (2018) and Wilhelm (2020) show how first-order counterpart theory

[Wilhelm (2020) treats sentences like W using a first-order counterpart theory, by treating “water” as a singular term. I think that “water” here functions as a generally quantified property like “sharks” in “If sharks ate lettuce they’d have the biggest salads” and I take my property-counterpart treatment in §2 to be an extension of Wilhelm’s discussion in a richer language. Similarly C´espedes (2011) argues that Humeans can use counterpart theory to accommodate dispositional essentialist intuitions.]}
can handle counteridenticals, an interesting subset of the countermetaphysicals I address here.

Higher-order counterpart theory makes the same move as first-order counterpart theory but applies it to properties. Properties, like individuals, have *property counterparts* at other words; properties which are similar enough to the actual world property to stand in for them at that world. So if water could have frozen at 40°, there is a world at which some property, which is sufficiently similar to water, is such that things which have that property freeze at 40°. This property is the property counterpart to water.

Most presentations of counterpart theory presuppose that individuals exist at only one world; this worldboundness implies that our counterparts at other possibilities are never us. As Schwarz (2014) points out, though, world-boundness isn’t an essential feature of counterpart theory; counterpart theory can be applied to situations where one’s counterpart is oneself just as easily as those in which one is not identical to one’s counterpart. Counterpart theory, according to Schwarz, is primarily useful in modelling shifts in reference, and explaining apparent referential variability in modal contexts. As I point out in §3.1, a counterpart theorist who accepts trans-world property identity can appeal to counterpart theory to handle the problem cases while easily distinguishing metaphysical possibilities from impossibilities. Consequently, I will remain neutral with respect to the question of whether objects and properties exist at multiple worlds.

The counterpart relation between individuals is typically taken to be a relation of similarity: if I have a counterpart who is a contender, this contender had better be similar to me in some contextually salient way. Perhaps they have my beliefs, my parentage, or perhaps they have a similar natural athletic ability to mine.

Property counterparts must also be similar to one another. Similarity between individuals is often cashed out in terms of shared properties; to make the same move for properties we would have to invoke a potentially infinite chain of higher-order properties. To avoid this, I follow Heller (1998) in taking property similarity to be structural. On Heller’s view, two properties are similar just in case they feature in the same or sufficiently similar Ramsey sentences. Since each property features in multiple Ramsey sentences, different counterpart relations can be constructed on the basis of these different profiles; these different counterpart relations will highlight different roles the property plays. This is similar to, but importantly distinct from, causal essentialism about properties. Rather than holding that some particular Ramsey sentence gives the nature of a property, and so is essential to it, higher-order counterpart theory allows different Ramsey sentences to be the basis of different counterpart-relations, and allows for counterpart relations to be based the similarity of the causal role a property plays even when that role is different in some way.

Heller advertises property counterpart theory as a neat way to capture many

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8 This move is also suggested by (Lewis 2015, p.16).
9 Probably not.
of the intuitions we have about the modal structure of properties without re-
lying on quiddities, or ungrounded facts about trans-world property identity.
Unlike essentialist views, though, property counterpart theory captures intu-
itive fact that some fundamental properties, e.g. charge, could have played a
different role in the laws of nature than they in fact do. For example, on
counterpart theory we can meaningfully consider how charge would behave if
Coulomb’s constant were different, or electromagnetic attraction operated via
an inverse-cubed law, whereas essentialists take this to be impossible. Similarly,
Hellerians don’t have to decide whether Newtonian mass is essentially gravita-
tional, inertial, or both—there are counterpart relations corresponding to each
role. Essentialists, on the other hand, are committed to choosing one of these as
giving the essence of Newtonian mass. Heller argues that these are often cases
where the Ramsey sentence at some world is different, but sufficiently similar,
to the Ramsey sentence the property feature in at the actual world.
I’ll take advantage of this later to make the distinction between metaphysical
and nomological counterparts of a property: some Ramsey sentences explicate
the grounding or metaphysical structure of a property, while others give its
nomic role. In both cases, finding the counterpart of a property relies on our
identifying counterparts of other properties. For example, if the nomological
counterparts of mass all cause instantiations of gravitational force, then in order
to find the counterparts of mass at a world, we also need to find a counterpart for
force. Similarly, if the metaphysical counterparts of water are all composites of
hydrogen and oxygen, then we need to locate counterparts of these properties at
a world in order to find a counterpart of water which matches its metaphysical
Ramsey sentence.
As I’ve indicated, it’s open to defenders of property counterpart theory to
take at least some of these properties to be the very same as the properties in the
actual world. But not all counterpart theorists will be comfortable relying on
these quiddities; those theorists, like [Heller (1998)], will take property similarity
to be a fairly holistic affair. Whether one property at a world is a counterpart of
water, in either the nomological or metaphysical sense, will depend on a robust
web of related properties.
I’ll also consider property counterparts which are similar to the actual-
world property they represent by having the same or a similar extension. This
might generate the following worry: first-order counterpart theory bases its
similarity relation on shared properties. If those shared property’s counterparts
are determined by which objects instantiate the properties at a world, we are in
too tight a circle. Fortunately, things are not so closely tied. Just as identifying
a Ramsey sentence for a property requires us to find counterparts of other
properties, we can identify our objects by finding the other properties they
share, and then use these objects to find the counterpart of the property they
instantiate. In these cases I’ll assume that the objects in the extension of the
property is picked out by the other properties the object has.
An illustration will make this less abstract. Suppose we’re discussing sports
at David Lewis High, our local high school. After a discussion of the popular
basketball team and its players, I might say “if it were colder here, basketball
could easily have been hockey.” Depending on what’s going on in our interests and shared background knowledge, I might mean that hockey could have played the same role in the social life of students at DLH that basketball in fact plays. But I might also mean that the students who play basketball could have instead played hockey. If I mean this latter thing, the counterparts of the students will be picked out by a similarity relation that does not include which sport they play—they will be counterparts of the actual students because they go to the same classes, eat in the same cafeteria, and have the same parents. The property of playing hockey will be the counterpart of the property of playing basketball in this world because the students who play it are counterparts of the actual-world basketball players. But their counterparthood is based on the sharing of properties other than playing basketball. The sharing of these properties determines the counterparts of individuals; the fact that these individuals are in the actual extension of basketball-playing makes the sport they counterfactually play—hockey—the counterfactual counterpart of basketball. In general, whether one property is similar enough to another to be its counterpart will depend on the counterparts of other properties and individuals; in this way, property counterpart relations are often determined holistically.

On both first-order and higher-order counterpart theory, the same world can represent multiple possibilities by being examined under distinct counterpart relations. Following (Lewis [1986b] p. 23), I will call worlds examined under a specific counterpart relation “possibilities”. It is possibilities, rather than possible worlds, which feature in modal and counterfactual discourse.

### 2.2 Handling the Problem Cases

Let’s turn to the problem cases from §1. The task here is simple: in order to show that property counterpart theory provides a possibility which satisfies the antecedent of these conditionals, I need to show that (a) there is a consistent world where some property satisfies the antecedent, and (b) this property is connected to the relevant actual-world property by some reasonable counterpart relation. Since counterpart relations are reasonable just if they are based on satisfaction of similar Ramsey sentences, or similar extension, I will show that the relevant properties play one or both of these roles.

It’s worth noting here that some of the problem cases are controversial on their own: philosophers convinced that water would obey the Navier-Stokes equation might not be so sure about the truth of Humeanism, and Humeans committed to nontrivial counterfacts about empty worlds might have doubts about counterfactual models of grounding dependence. My goal here is not to establish the truth of falsity of these particular counterpossibles. I think that there is a strong case to be made for each of these ([Tan](2019), [Wilson](2016), [Bhogal](Forthcoming)), but this is not the place to make it. Rather, I aim to

10 Things are slightly easier if we generate our impossibilities using the grafting strategy discussed in §3.1; then we can take advantage of trans-world identities for most properties and individuals to find non-trivial counterparts for a few that are of interest to us.
show that, assuming (in line with the arguments in the cited papers) that these are nontrivially true or false, the best way to make sense of this is via property counterpart theory. I do however want to argue that there are some nontrivial counterpossibles; if you, dear reader, accept just one of these examples I will consider my case made. Another caveat: counterpart relations are by their nature context-dependent. Consequently my aim here is to establish that there are counterpart relations available which will make these nontrivial in some contexts, not to show that they are nontrivial in all contexts. Contexts shift and counterpart relations shift with them; while I think these counterpart relations capture similarity relevant to some contexts, it would be extremely surprising if they were operative in all contexts. First, consider Tan’s example W:

(1) “W: If water were a continuous, incompressible medium, then it would behave as the Navier-Stokes equations describe.” (Tan 2019)

Accommodating W in the property counterpart model requires us to find a consistent world in which there is a continuous, incompressible medium which is similar to water in its behavior. In the actual world, water is a fluid which flows in rivers and pipes, pools, and takes the shape of its container. Continuous counterparts of water will also play these roles and exhibit typical watery behaviors, such as floating boats and wetting whistles. If the closest such counterpart obeys the Navier-Stokes equation, then W is true. In fact it does—the Navier-Stokes equation can be derived from assumptions including continuity and incompressibility, so since the worlds we consider in property counterpart theory are consistent, water’s incompressible continuous counterpart will precisely obey the Navier-Stokes equation and W will be true.

In order for water to have a continuous, incompressible counterpart, water must have at least one counterpart that is not H\textsubscript{2}O, since composites of H\textsubscript{2}O molecules are not continuous or incompressible. If water is essentially H\textsubscript{2}O, then water could not be this incompressible medium. This counterpart, then, is an impossible counterpart of water. The antecedent is impossible, not because it takes us to an impossible world, but because the property-counterpart of water is a property that could not be water.

Now to grounding counterfactuals. I’ll focus on CF3, since property counterpart theory agrees with standard counterfactual semantics in taking CF1 to be true.

(2) “CF3. If an intervention had prevented Singleton Socrates from existing, then Socrates would not have existed. — False” (Wilson 2016)

Dealing with grounding counterfactuals like CF3 is somewhat trickier. It requires us to find counterparts of Socrates, Singleton Socrates, and the set membership relation, such that Socrates’ counterpart does not bear the membership

11Note that this argument requires conditional proof; I show in Appendix B that conditional proof holds on counterpart-theoretic semantics for D+.

12It's worth noting here that this requires continuous fluids to be genuine metaphysical possibilities; although move views of metaphysical possibility accept this, some nomic necessitarians, like Wilson (2020) or Kimpton-Nye (2020) might not. Thanks to [redacted] for discussion of this point.
relations’ counterpart to Singleton Socrates’ counterpart. This is because an intervention on Singleton Socrates must leave Socrates unchanged, and sever the set membership relations which are “upstream” from Singleton Socrates.

As in the case above, this world is self consistent. But the objects and relations in the world, which stand as the counterparts of Socrates, Singleton Socrates, and the set membership relation, could not possibly be Socrates, Singleton Socrates, or membership—since necessarily, Socrates is a member Singleton Socrates. How then can they be counterparts to Socrates, Singleton Socrates, and the grounding relation?

Call the counterpart of the membership relation at this world the “membership*” relation, and the counterparts of Socrates and Singleton Socrates “Socrates*” and “Singleton*”. One way for the membership* relation to be sufficiently similar to the grounding relation to count as its counterpart is for it to relate every counterpart of an individual to the counterpart of that individual’s singleton, with the sole exception of Socrates* and Singleton*. The membership* relation nearly matches the membership relation in both Ramsey sentence and extension. The membership* is a strict subrelation of the membership relation, differing from it in only one instance. Such a relation would be similar enough to the membership relation to be one of its counterparts at this world. Since the antecedent requires us to find a possibility—that is, a combination of counterparts together with a world—on which Socrates has no Singleton, this counterfactual will take us to the possibility where membership* (rather than membership) is the counterpart of the membership relation. Of course, the membership relation also exists at that world, and there is a distinct possibility according to which membership, rather than membership*, is the counterpart of membership that world. But this possibility is not the closest possibility where the intervention has been performed, because it simply is not a possibility where the intervention has been performed; even though membership* is less similar to membership than membership is to itself, it is the most similar counterpart which satisfies the antecedent of the counterfactual.

The single exception to the membership* relation at this world looks quite a bit like one of Lewis’s “tiny miracles” for typical counterfactuals. On Lewis’s view, counterfactual antecedents typically take us to worlds which precisely resemble our world in the past, and precisely obey our laws in the future. But to satisfy the counterfactual antecedent, there is a very small violation of the laws in the present. On many views of metaphysical dependence, these cases are close parallels. On views which regard grounding relations as governed by metaphysical laws, such as Wilsch [2015] or Schaffer [2017b], they are both cases of law-breaking to satisfy the counterfactual antecedent.

Finally, how should Humeans and nomic necessitarians deal with appar-

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13It might seem strange to imagine a world where set abstraction doesn’t apply to this one instance. While I agree that, if Socrates has a singleton set, he necessarily has one, I don’t think membership* is so different from membership. For note that we cannot assume that every collection of objects has a set containing it without invoking paradox. (Actual) set membership is like membership* in failing to apply to some collections; membership* just differs in having one particularly small finite collection without a containing set.

14
ent worlds in which the laws are metaphysically impossible—for example, the empty Minkowski world with general relativistic laws?

(3) \textit{simplegr}_2: If you added a mass to an empty spacetime governed by the laws of General Relativity, that spacetime would not remain flat.

To keep things simple, I'll assume that lawfulness is a property of regularities, where a regularity is the collection of a law's instances. Non-Humeans hold that this property is basic; Humeans hold that it is grounded in global facts about what best summarizes the Humean mosaic.

At simple worlds, multiple law-systems have exactly the same instances, and so multiple distinct regularities wholly overlap. This is similar to the mereological overlap of objects, like the statue and lump, and I think that we can appeal to the same sort of counterpart-theoretic solution that Lewis (1971) applies in that case. One particle moving inertially is an instance of Newtonian gravitational mechanics, but also of a law stating that all objects move inertially; an empty Minkowski space is an instance of GR, as well as SR + N. The counterpart relation determines which of the properties of that instance—being a regularity of GR or being a regularity of SR + N—is lawful.

In some contexts, the relevant counterpart of \textit{being a law} at the empty Minkowski world is a property had by the regularities of GR; in other contexts, the law-counterpart is a property attached only to the laws of special relativity. The laws at this world are the same at at our own world, so the property-counterpart of \textit{being a law} has the same extension as the property at the actual world.

Because (on Humeanism) \textit{being a law} is a property a regularity has in virtue of fitting into the Best System, it's metaphysically impossible for a regularity to be a law without fitting into that system (correspondingly, on necessitarianism, \textit{being a law} is had necessarily if at all). Nonetheless, regularities that are laws at one world can have law-counterparts at worlds where they are not the best system; these counterparts are similar in virtue of having the same content, or being the same regularity, rather than in virtue of fitting into the best system. The property is similar to \textit{being a law} because it has the same extension even though it does not have the same grounding structure.

\textit{simplegr}_2 takes us to such a world: a world where the counterpart of \textit{being a law} attaches to the regularities of GR, rather than to the axioms of the Best System. At this world, adding mass does not result in a flat spacetime; consequently \textit{simplegr}_2 is false (and \textit{simplegr}_1 is true.

In all three cases, the relevant worlds are internally consistent, but the counterpart relation relates objects or properties to things which they could not be. Although these things are similar in some respects to one another—similar enough for there to be a counterpart relation linking them—there is a strong sense in which, for example, water simply could not be an incompressible continuous material, \(\in\) could not fail to connect Socrates and \(\{\text{Socrates}\}\), and the laws must be the axioms of the Best System.
3 Modelling Impossibilities

3.1 Impossible Counterparts

The counterpart relations involved in counterpossible counterfactuals are weird. They link individuals and properties with things which they could not be. But given that what it is for something to be possibly some way, according to modal counterpart theory, just is for it to have a counterpart that is that way, it’s hard to see in what sense the antecedents are impossible, or why we judge that, e.g., water could not be an incompressible continuous material.

Collapsing this distinction may matter little for the counterpossibles discussed in Tan (2019), but it would be a pyrrhic victory for the Humean, the necessitarian, or the grounding theorist. If the Humean can’t make sense of the distinction between metaphysically possible and impossible worlds, then the distinction between Humean and non-Humean views is at risk of collapse. If the Humean and non-Humean both think that there could be laws which aren’t elements of the best deductive system of facts that world, but disagree only on what label we should give those possibilities, then their disagreement doesn’t seem substantive. It seems instead like a discussion about what labels we should attach to non-actual possibilities.

It presents a similar difficulty for the proponent of interventionist grounding models. Grounding is supposed to be a form of metaphysical dependence. If grounding relations are contingent, it’s difficult to see in what sense the grounded depends on its grounds. If Socrates Singleton could exist without Socrates, in what way does the singleton depend on its element?

We can escape this bind by showing that on the new framework, metaphysical possibility is privileged. Fortunately, a counterpart-theoretic framework has plenty of resources to accomplish this. I will here outline two strategies: the grafting strategy, and the legislating strategy.

The grafting strategy attaches the mechanisms of counterpart theory to an existing, well-developed metaphysical theory of possibility. Luckily, the counterpart-theoretic framework can be grafted onto any account of possible worlds without doing significant damage to its host. Recall that we did not stipulate that properties (or objects, for that matter) are world-bound. This allows philosophers with a well-developed theory of possible worlds to take the metaphysical possibility to be those at which each property’s counterpart is itself. This strategy allows us to retain the idea that the metaphysical possibilities represent the way things really could be, while nontrivial counterpart relations allow us to examine how things would have been had they been different.

The grafting strategy will work for a wide variety of theories of possible worlds. For example, philosophers who follow Stalnaker (2011) or Plantinga (1974) in holding that worlds are maximal properties can take each metaphysical possibility to be one of these worlds, with each property serving as its own counterpart. The metaphysical impossibilities will also be these worlds, but with an expanded counterpart relation on which some properties “stand in” for others. This view of worlds allows for a neat explanation of the essential
nature of kinds, like water. Water is (metaphysically) necessarily \( H_2O \) because water is in fact \( H_2O \), and so it is \( H_2O \) at every world where it represents itself (at those worlds, of course, it is also represented by \( H_2O \)). Since water’s continuous counterparts are not molecular, they are not \( H_2O \), and so must be represented by some distinct property. Since this property is not (in fact) water, these possibilities are metaphysical impossibilities. They are not impossible worlds, though—they are possible worlds examined through an impossible counterpart relation.

Similarly, philosophers who take the metaphysically possibilities to be determined by the essential natures of properties (such as Vetter (2015) or Bird (2007)) or the laws of nature (such as Wilson (2020)) can take the metaphysical possibilities to be represented by worlds and properties which obey the laws which are determined by the essences of properties, or the laws of nature (respectively). They can then use non-trivial counterpart relations to construct metaphysical impossibilities out of these metaphysically possible worlds. There are some limitations to this strategy; while dispositionalists countenance possibilities with alien dispositions, and so have plenty of room for countinous substances which obey the Navier-Stokes equation (but are not, recall, water), necessitarians like Wilson (2020) may not have quite such a rich set of alternative properties to work with. For such necessitarians, whether there are continuous substances, compatible with our actual laws, suitable to make true counterfactuals like \( W \) is an open empirical question.

But not all philosophers have such a robust conception of metaphysical possibility; some philosophers take possibilities to be abstractions from our linguistic practices, belief and cognitive states, or modal discourse itself. In the categories of Lewis (1986a), these philosophers are linguistic ersatzists or magical ersatzists. For these philosophers, the distinction between metaphysical possibilities and impossibilities does not flow as easily from the nature of possible worlds. Rather, it must be imposed on them. I advise these philosophers to distinguish metaphysical possibilities from impossibilities by legislating: they should hold that, as a rule or matter of principle, some counterpart relations correspond to metaphysically possible counterparts, and others do not. This is a line in the sand: on one side are metaphysically possible counterparts, on the other, impossible ones. On this view, metaphysical possibilities are a restriction on the space of possibilities, a special and privileged subclass.

To make the legislative strategy work, we need a principled way of making this distinction. One way to do this is to simply stipulate that the metaphysical possibilities are those which correspond to our intuitions about the metaphysical facts. On this view, there just are some properties which water (metaphysically) could be, others which it couldn’t. The set of counterpart relations that picks out those properties is metaphysically privileged, and that’s all there is to it. This mirrors the conventional approach of Sider (2011). Because the stipulation here is brute, this is a brutal version of the legislative strategy.

A brutal legislative strategy would leave metaphysical necessity mysterious. But laws without justification are at risk of being overturned. A better way, on my view, would be to take the metaphysical counterpart relations to be those
which preserve the actual world’s metaphysical structure.

Metaphysical structure includes the structure of identity relations and identity-like building relations (see Bennett (2017) for an account of building relations, and Schaffer (2017b), Schaffer (2017a) for a defence of a legislative view of grounding). If some entity \(a\) is grounded in some other entity \(b\), a counterpart relation which takes \(a\) and \(b\) to objects which don’t bear the grounding relation to one another, or which takes \(a\) to some ungrounded object, is a metaphysically impossible counterpart relation.

Many theorists take grounding, or metaphysical dependence, to be primarily a relation between facts, rather than a relation between things. And this makes sense: while there are a few relations between objects which seem metaphysically privileged, for example relations of identity, set membership, or mereological relations, few grounding relations can neatly be construed as object to object or even property to property relations. One example particularly salient to this paper is the Humean account of laws: a regularity is a law in virtue of featuring in the best system. It’s easiest to view this in virtue of relationship as holding directly between facts, rather than between properties.

But this doesn’t leave us totally out to dry: we can still say that a counterpart relation preserves metaphysical structure just in case it preserves metaphysical dependence relations between facts. A counterpart of the property being a law which picks out regularities which are not in their world’s best system doesn’t preserve metaphysical structure, even if this structure isn’t explicitly represented as a relation between objects or properties. Metaphysical structure is built out of the dependence relations at the actual world. These relations include (but aren’t limited to) first-order identity, property identity, and mereological structure. These relations tend to hold between entities which are not entirely distinct; metaphysical possibility, then, is special because it doesn’t make distinctions between indistinct objects.

The counterpart relations in §2.2 do not preserve metaphysical structure. In the actual world, water is composed of hydrogen and oxygen; its continuous counterpart is not composed of hydrogen and oxygen. By connecting the natural kind water to a property which lacks compositional structure, the counterpart relation fails to preserve metaphysical structure.

Similarly, and in a rather obvious way, the counterpart relation linking Socrates to Socrates* and Singleton Socrates to Singleton* fails to preserve the relation of set membership, and so fails to preserve metaphysical structure. Finally, worlds in which the laws are not part of the world’s best system are worlds at which the laws—which are in fact grounded in the nonmodal facts about the world—are ungrounded or fundamental.

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14This is, of course, too simple. For many higher-level properties are grounded by being functionally realized at a lower level. In these cases, it suffices that some realizer exist for each counterpart of the kind. Naturally, even this caveat will not capture all cases; the complexities of grounding are, alas, beyond the scope of this footnote.
3.2 Impossible Counterparts or Impossible Worlds?

Property counterpart theory is not the first attempt to tackle counterpossible counterfactuals; it is merely the first attempt that does not appeal to impossible worlds. But not to worry: the counterpart-theoretic semantics has some interesting advantages over approaches to counterpossibles based on impossible worlds rather than counterpart impossibilities. Impossible worlds approaches can be found in Berto et al. (2018), Bjerring (2014), Laan (2004), Jago (2013). For a novel approach which uses fictions instead of counterparts nor impossible worlds, see Kimpton-Nye (2020).

First, the counterpart-theoretic semantics allows us to retain some attractive logical inferences that aren’t preserved on impossible-worlds based approaches. Because counterpart impossibilities are possible worlds, examined under a strange similarity relation, they are complete and consistent. Consequently, as I prove in the appendix, the consequents of these counterpossible suppositions are closed under logical entailment. So if \( A \vdash B \) and \( B \vdash C \), then \( A \vdash C \). Similarly, if \( A \vdash B \) and \( A \vdash C \), then \( A \vdash B \& C \). These features are attractive, since in many of the troublesome cases, including those most useful in scientific contexts, we are interested in reasoning deductively about the consequents of counterpossible suppositions.

Second, the impossibilities of counterpart theory more transparently represent the structure of these counterpossible suppositions than extant accounts of impossible worlds. Accounts of impossible worlds either take impossibilities to be maximally inconsistent sets of propositions (as in Laan (2004)) or incomplete ways things could be (as in Bjerring (2014), Priest (2016)). These are well-suited to model situations which are impossible because they are inconsistent according to some logical system, but not well-suited to model impossibilities that are not possible because of the nature of the properties or relations that feature in them. This sort of metaphysical impossibility does not lead to any logical inconsistency or incompleteness. The easiest ways to accommodate Tan’s W counterfactual in these systems would either take facts about water to be

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15 Another alternative that bears some similarity to the present approach is that of ?. Handfield combines a paraphrase theory with 2-dimensional semantics. He paraphrases claims like “If water were XYZ, then ...” as ‘if water had turned out to be XYZ”, and treats these roughly as indicative conditionals. My proposal has two primary advantages over Handfield’s: the first is that my proposal is not a paraphrase theory, it is rather a semantic theory for ordinary counterfactuals. I think the charitable presumption that competent English speakers say what they mean, and are often right, inveighs against paraphrase theories and in favor of realist semantic theories. Second, my view more easily accommodates the fact that we take “If water were XYZ, then XYZ would fill our lakes and streams” to be true but “if the queen were a robot, everyone would be a robot” to be false. These are natural because the first takes us to a world where water’s property counterpart is XYZ, and so XYZ plays waters role; the second takes us to a world where only the queen’s counterpart is a robot, so the rest of us are humans. Handfield’s account awkwardly attempts to handle these by balancing constraints which pull in the direction of taking everyone to be a robot if the queen is (see p. 418).

16 Whether these desirable properties are preserved on Kimpton-Nye’s approach depends on the features of the true-according-to-the-fiction operator. For example, as I understand Kimpton-Nye’s proposal, multi-premise consequent closure will hold just in case truth according to a fiction is closed under multi-premise entailment (I am not sure that it is).
logically equivalent to or represented by conjunctive facts about hydrogen and oxygen, or to represent these worlds as asserting both $W = H_2O$ and $\neg W = H_2O$. But the counterpossible supposition that water is a continuous compressible substance doesn’t require us to take facts about water to be true conjunctive facts which lack true conjuncts (as in the incomplete worlds of [Priest (2016)]) nor do they require us to assume any explicit contradiction—according to this counterpossible supposition, $\neg W = H_2O$, but it’s not the case that $W = H_2O$. So we should not assume, as impossible-worlds theory requires, that impossibilities are either inconsistent or incomplete.

### 3.3 Referential Opacity

There is an important link between metaphysical impossibility and referential opacity in counterfactual conditionals. A sentence is referentially opaque just in case substituting co-referring terms can lead to a change in the truth of the sentence. Both [Williamson (2007)] and [Vetter (2016)] argue that nontrivial counterpossibles would give rise to referentially opaque contexts, and both argue that counterfactuals are not referentially opaque. They conclude that countermetaphysicals are trivial. Many of the counterfactuals we’ve discussed are opaque; for example water and $H_2O$ have, on standard semantics, the same semantic value, but substituting $H_2O$ for water in $W$ would change the truth-value of the counterfactual. This arises from the fact that metaphysical relations are relations holding between non-distinct objects; counterpart relations which fail to preserve the relations will not be extensional.

On Vetter’s view, typical counterfactuals are not referentially opaque; referential opacity is a sign that the conditional involves epistemic, rather than circumstantial, modality (a distinction found in [Kratzer (1991)]). Here’s Vetter’s argument:

“[A] modal’s giving rise to referential opacity is conclusive evidence for the epistemic reading. The reason is simply that circumstantial modality concerns the objects, properties, and relations that a given modal claim is about, not any representational or cognitive features of the terms we use to refer to them. A failure of substitutivity for names is generally an indication that what matters are certain representational features of the names, rather than the objects to which they refer.” (Vetter 2016, p. 2698)

Vetter’s argument is as follows:

- **P1**: Circumstantial modality concerns the objects, properties, and relations that a given modal claim is about.

- **P2**: A failure of substitutivity for names [e.g. referential opacity] is generally an indication that what matters are certain representational features of names, rather than the objects they refer to.

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17 In an earlier discussion in the same paper Vetter says “Coreferential names [...] differ qua signs,
P3 (unstated): The modality in question is either circumstantial or epistemic.

C: Referential opacity is conclusive evidence for the epistemic reading [of the modal or counterfactual].

Counterpart theorists should reject P2 here. Specifically, P2 seems to present a false dilemma. The representational features of names are of course relevant, in that, given a particular context, different names can generate distinct counterpart relations. But these different counterpart relations are not merely features of names and not objects or properties—the objects or properties have the counterparts they do because of their actual properties or roles. For example, water is both a fluid and a composite of hydrogen and oxygen[18]. The different names highlight different features of the actual object; these different features generate different counterpart relations, and those different counterpart relations give rise to different truth conditions. But these counterparts are counterparts of the object, and the object has them because of its actual features.

Because metaphysically possible counterpart relations preserve metaphysical structure, and because the identity relation is a paradigm case of a metaphysical relation, metaphysically possible counterpart relations will preserve the identity relation. Consequently, so long as a context only calls for metaphysically possible counterpart relations, it will be referentially transparent. This allows us to explain the fact that (as Williamson (2007) notes) substituting co-referential names often feels valid; this substitution is valid in contexts which only appeal to metaphysical possibilities. But by embedding these contexts in a semantics which handles the counterfactuals in §2.2, we also do justice to the intuitive readings of the counterfactuals in these non-metaphysical contexts.

3.4 Reductio Arguments

Williamson (2018) further argues that counterpossible models cannot account for some intuitively valid reductio arguments. Williamson’s complaint is that

Reflection suggests that the problem for opponents of orthodoxy goes deep. For consider any non-obvious impossibility a that can be shown, by more or less elaborate deductive reasoning, to lead to an obvious impossibility x. The general anti-orthodox strategy is to be charitable by evaluating counterfactuals with a as the antecedent at impossible worlds or situations not closed under such

[18] Berto et al. (2018) presents a similar response. Berto et al argue that Williamson seems to be assuming that hyperintensional differences are always representational differences, and correctly points out that this is too strong; here, I add to Berto et al’s response by showing what non-representational features make for the difference between necessarily equivalent antecedents: terms which actually have the same semantic value might give rise to different counterpart relations.
reasoning, precisely in order to falsify counterpossibles such as $a \implies x$. But those are exactly the counterpossibles one needs to assert in articulating the argument by reductio ad absurdum against $a$. (Williamson [2018] p. 363)

Because impossible-worlds based approaches often involve deductively incomplete worlds, inconsistent worlds, or worlds with other logical defects, one cannot reason deductively about the consequents of counterpossible suppositions. But such reasoning is common in reductio proofs—and more generally in the sorts of modelling situations discussed in this paper (for example, when we reason about how water would behave if it were continuous, we presume that we can use mathematical and deductive reasoning to do so). Impossible-worlds based approaches typically argue that, while not valid, this sort of reasoning is generally truth-conducive (see e.g. Berto et al. [2018]). In contrast, a counterpart-based approach to impossibilities leaves these inferences valid and allows us to retain the strict validity of this sort of reductio argument. I prove this in Appendix B and I take it to be an advantage of the counterpart-theoretic approach.

A related question involves our reasoning about what is possible and what isn’t. For the following inference seems valid, in at least some contexts:

$A \implies B$

$\neg \Diamond B \models \neg \Diamond A$

This is the sort of inference we often use when trying to determine if something is physically possible. For example, if I am trying to figure out if it’s possible to construct a space elevator, I might reason as follows:

**Space Elevator**: a space elevator constructed with a steel cable would have to withstand tensions greater than 350 GPa. It’s impossible to construct a steel cable which withstands tension anywhere near 350 GPa. So it is impossible to construct a space elevator out of steel. If I come up with a better elevator design—for example, one with a tapered cable—I might reject the counterfactual (actually, I might think, a steel space elevator would only need to withstand tensions for around 300 GPa) even if I ultimately conclude that such an elevator is impossible (steel cannot withstand these lower tensions anyway).

Before moving on, I’d like to bring up an interesting feature of **space elevator**. It is not clear whether the modality involved in **space elevator** is physical or metaphysical, since the impossibility results from structural and so plausibly essential features of steel, together with the dynamic laws of the actual world which govern planetary orbits. Consequently it would be worthwhile

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19The hope for such an elevator created out of carbon nanotubes is greater, as they are lighter—and so would be subject to less tension, as the weight of the cable is the main source of tension for a space elevator—and have a much greater tensile strength (Hamer and Nakroshis [2014]).
to seek a unified treatment of our reasoning about physical and metaphysical impossibility; the counterpart-theoretic solution does just that.

Whether this sort of reasoning is valid for counterpossibles depends on whether, for any \( A \) which is possible, the closest \( A \)-possibility is really possible. If some impossibility is closer than a possibility, according to our similarity relation, then it might be that \( A \sqsupset B \) for some impossible \( B \) even though \( A \) is possible. We can add a rule to our semantics ruling this out; that rule is typically called the Strangeness of Impossibility Condition (SIC) \([\text{Nolan}, 1997, 550]\), \([\text{Berto and Jago}, 2013, \text{p. 271}]\). A similar condition is advocated in \([\text{Lange}, 2009, \text{p. 64}]\). While Berto et al focus on the strangeness of logical or metaphysical impossibility, Lange’s lessons are drawn from reasoning about physical possibility. Lange then argues that this condition holds for all modals.

If we accept this principle or a similar one, we can use counterpossible conditionals to reason about what is possible for many different sorts of possibility. Williamson considers this a retreat:

“One fallback would be to concede orthodoxy for counterlogicals, countermathematicals, and the like, but still reject it for some countermetaphysicals. Not only is that a long retreat, it risks undermining the motivation for the residual resistance to orthodoxy in the first place, since the motivating features of the examples are already present in the case of the counterlogicals. If those features are somehow illusory, who is to say that similar illusions are not also at work in the case of the countermetaphysicals?” \([\text{Williamson}, 2018, \text{p. 363-4}]\).

I am not sure whether the present approach extends to countermathematical or counterlogical counterfactuals. But metaphysical modality, like physical modality, is \textit{a posteriori}. Both are generated by dependencies and patterns that we learn about through interacting with the world. So it is reasonable to expect our understanding of the two modalities to function in similar ways. Reasoning about what is physically possible or impossible often involves nontrivial counterphysicals (as in \textit{space elevator}); reasoning about metaphysical impossibility similarly involves nontrivial countermetaphysicals (for example, if water were a continuous incompressible fluid, it is not the case that it would freeze. This sort of reasoning gives us evidence that water is not continuous.). Consequently I think that, rather than being a fallback position, grouping these modals together is natural and intuitive, and that similarity is captured by the counterpart-based approach.

4 Ersatzism and Representation

Property counterpart theory’s most prominent exploration \([\text{Heller}, 1998]\) explicates the view in an ersatzist framework. Both linguistic and “magical” ersatzism are natural settings for property counterpart theory, since their metaphysics doesn’t implicitly involve trans-world property identity.
The strategy discussed above creates two problems for linguistic ersatzism. The first is that property ersatzists and most linguistic ersatzists take the language used to construct the world to consist only of fundamental predicates, with nonfundamentalia represented only implicitly at the worlds. But the framework I’ve just described explicitly represents grounding relations and non-fundamental entities. The second problem is that many linguistic ersatzists take worlds to be sets of sentences in a Lagadonian language (see e.g. (Wang 2015, p. 421), (Sider 2002, p. 282), and (Melia 2001, p. 20)), where properties are their own names. In this language, trans-world property identity seems especially natural; meanwhile many ersatzists are property ersatzists along the lines of Stalnaker (2011) or Plantinga (1974), where trans-world property identity seems guaranteed. I’ll take these in turn.

4.1 Implicit Representation

Standard ersatzist theories take possible worlds to be maximally consistent sets of sentences in a fundamental language. The world does not explicitly represent nonfundamental objects; rather, these objects are implicitly represented by the fundamental objects. If the fundamental facts at a world imply that there is some sort of nonfundamental object (say, a donkey), then the world represents a donkey by implying that a donkey exists.

Lewis (1986b) argued that implicit representation of this sort involved unreduced modality. Since the implication relation (between, say, simples-arranged-donkeywise and donkeys) had to be assumed before the models are interpreted, the models could not provide an explanation of some modal truths (for example, that necessarily if there are properly connected donkey parts there are donkeys).

The present proposal cannot, I think, deliver a reduction of modality that would satisfy Lewis. But I think it does a better job than models which rely on implicit representation. For on the present proposal, nonfundamental entities like donkeys are explicitly represented. They are represented as distinct from their parts, but connected to these parts via a relation of mereological fusion. Rather than stipulate that donkeys exist at every world with donkey parts, we instead demand that metaphysically possible counterpart relations preserve mereological relations. As a result (rather than by stipulation) it is metaphysically necessary that donkeys exist at every world where donkey-parts do. It is the grounding structure of the actual world, projected onto these worlds, that insures the existence of nonfundamental objects there. The modality is not explained by the possible world models; it is instead explained by actual-world grounding relations between fundamental and nonfundamental objects.

4.2 Ersatz Languages

Many actualists who subscribe to linguistic ersatzism take the relevant language to be Lagadonian, where a Lagadonian language is one in which each property stands for itself. This move serves two purposes: first, it insures that the sentence
is rich enough to give us enough possibilities (there are cardinality concerns if the language is finite), and second, it insures that the account is sufficiently actualist.

This move looks somewhat strange for property counterpart theory. After all, if properties stand for themselves, why not allow for trans-world property identity? Similar considerations inveigh against a form of property ersatzism which takes possible worlds to be constructed directly from properties as in Stalnaker (2011) or Plantinga (1974). However, there is no direct argument from Lagadonian ersatzism against property counterpart theory. The principle motivation for using a Lagadonian language to construct our worlds is to insure that the language is sufficiently rich and sufficiently actualist. The language needs to have enough predicates to describe all of our world’s myriad properties; Lagadonianism secures this. And the language must be sufficiently actualist to satisfy a modal ersatzist suspicious of the inflated ontologies of the varieties modal primitivists. This too is secured by the fact that the predicates are real-world, actually instantiated properties. Neither of these requirements prevents us from adding a counterpart relation to our modal semantics. Possible worlds constructed using actual world properties will be attractive to grafters (§3.1) especially since employing the tools of the counterpart theory described here, may help the Lagadonian make sense of alien properties, since the counterpart theorist can represent alien properties using actual properties by severing the counterpart connection to the actual world.

## 5 Conclusion

Scientific practice and metaphysical modelling posit a variety of non-trivial counterpossible counterfactuals. But these counterpossibles don’t fit neatly into our current models of counterfactuals, even those which posit impossible worlds. Here, I’ve argued that a model based on property counterpart theory can handle many of the problem cases, while making sense of the idea that these counterfactuals have impossible antecedents.

In closing, I’d like to fend off a worry one might have about property counterpart theory, especially a property counterpart theory built on an ersatzist understanding of possible worlds. This objection is along the lines of the Humphrey objection to first-order counterpart theory. One might think that what’s possible for water should constitutively involve water in a way that water’s counterparts at these worlds—whether they are linguistic entities or just other properties—just doesn’t. When I think of the possibility that water can become Ice-9, I am not considering a set of numbers or a conjunction of logical symbols; I am not thinking about some non-water property and asking how much it is like water. I am thinking about a way the world could be, and what water could be like! I think that this intuition is one of the sources for support for modal realist views against ersatzist views. But a little thought shows that it is misguided.

Possible worlds do a lot of work in contemporary philosophy, and most of
this work stems from their position as the content of thoughts and sentences. Sets of possible worlds are used to model propositions. Possible worlds are, in this line of thinking, abstract representations. Models of possible worlds are representations of our representations of the world.

Now, nobody really thinks that representations have to be the same sort as the thing they represent. Nobody thinks that if a mountain is made out of rocks you can’t map it using paper, or that for a feeling to be captured by a song that feeling must be made out of sound waves. And thoughts and sentences are themselves very different from the things they represent, both in substance and structure.

When we provide models of content, we are creating metarepresentations. If we’ve accepted the obvious fact that representations can be wildly different in substance from the thing they represent, there is no good reason to require higher-order representations to be metaphysically like the target of their representation. Our models of possible worlds can be whatever we want them to be, so long as the way in which they represent the content of our thoughts and sentences is clear. And, when it comes to the property counterpart theory, I’ve argued that it is.
A The Counterpart-Theoretic Model

Thank you for reading the appendix. Here I will sketch a higher-order counterpart-theoretic model for counterfactuals. The semantics is loosely based on that of Kocurek (2018) and Kracht and Kutz (2005), extended to accommodate the higher-order counterpart relation. Useful resources on the semantics of counterpart models can be found in Kracht and Kutz (2002), Russell (2013), and Schwarz (2014).

A.1 Counterpart Models

- **Language:** we will use the standard language of first-order predicate logic without constant terms.

D1 Structure: A structure is a tuple $S = \langle W, D, d, I \rangle$, where $W$ is a set of worlds, $D$ a set of objects disjoint from $W$, and $d$ a function from worlds to subsets of $D$ ($d : W \rightarrow \mathcal{P}(D)$). Intuitively, $D$ contains all possible objects and $d$ tells us which objects exist at each world. For each $w \in W$, we will write $D_w = d(w)$.

D1.1 Intension: An Intension is a function $I^n : W \rightarrow \mathcal{P}(D^n)$ from worlds to sets of elements of $D^n$.

D1.2 The extension of $I$ at $w$ is the set $E_w$ assigns to $w$. We will write this as $E_w = I(w)$. We require $E_w \subseteq D_w$.

D2 Counterpart Relation A counterpart relation is a function $C \subseteq ((D \times W)^2 \cup (I \times W)^2)$. That is, it relates object-world pairs to one another and intension-world pairs to one another. (This is the primary departure from Kracht and Kutz (2005), to accommodate higher-order counterparts). I also stipulate here that $C$ delivers at most one counterpart at each world; note in the following that a model contains a set of counterpart relations and so objects can have multiple counterparts at a world, each under a different counterpart relation.

D3 Counterpart Frame: A counterpart frame $F$ is a tuple $F = \langle S, C \rangle$ consisting of a structure and a set $C$ of counterpart relations.

D4 Counterpart Structure A counterpart structure is a pair $\langle F, N \rangle$ where $F$ is a counterpart frame and $N$ is an interpretation.

D4.1 Interpretation An interpretation $N$ is a function which assigns to each n-ary predicate an intension $I^n \in I$. We will call the extension at $w$, $E_w$, of the intension $N$ assigns to the n-ary predicate $P^n$ “$N_w(P^n)$”.

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20 We will not require that objects are worldbound, that is, we will not require that each object exists at only one world.

21 If properties are worldbound, in the sense of Heller (1998), then $E_w = I(w) = I$. 

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D5 Possibility A possibility on a frame is a pair \( \langle w, C \rangle \) where \( w \in W \) and \( C \in C \). We will write this \( w_C \).

- We will call the set of possibilities of a frame \( \text{Pos}(F) \).

D6 Selection Function: A selection function on \( F \) is a function \( f : P(\text{Pos}(F)) \times \text{Pos}(F) \rightarrow P(\text{Pos}(F)) \). That is, it takes us from a set of possibilities and a world to a set of possibilities.

- To recover the full logic of counterfactuals of Lewis (1973) we would need to further constrain the selection function, but to simplify this section I keep things minimal.

D7 Counterpart Model A counterpart model is a quadruple \( M = \langle F, N, \eta, f \rangle \) where \( F \) is a counterpart frame, \( N \) is an interpretation, \( \eta \) is a variable assignment, and \( f \) is a selection function on \( F \).

D7.1 Variable Assignment A variable assignment \( \eta \) is a function which assigns to every \( w \in W \) and every variable an element from the \( D_w \).

D7.2 Interpretation at a possibility An interpretation at \( w_C \) is a function which assigns to each world \( v \) and \( n \)-ary predicate \( P \) the counterpart which \( C \) assigns at \( v \) of the intension which \( N \) assigns to \( P^n \) at \( w \). We will write this as \( N^{\text{wc}} \).

D7.3 Assignment Countersets We will define a relation between variable assignments \( \rightarrow \) where, given a counterpart relation \( C \in C \) and worlds \( v \) and \( w, \eta \overset{C}{\rightarrow} \eta^* \) if and only if \( \eta_v(x), \eta_w(x) \in C \).

D7.4 Local \( x \)-variant We will say that \( \eta^* \) is a local \( x \)-variant at \( v \) if and only if \( \eta^* \) is a valuation that differs from \( \eta \) at most in the value it assigns to \( x \) at \( v \). We will write this as \( \eta^* \approx^x \eta \).

D8 Truth in a model. Let \( \phi(x) \) and \( \psi(y) \) be modal formulae with free variables \( x_1, ..., x_n \) and \( y_1, ..., y_n \), respectively, \( P^n \) be an \( n \)-ary predicate, \( M \) be a counterpart model, and \( w_C \in \text{Pos}(C) \).

We can now recursively define satisfaction \( \vdash \) at \( w_C \) in \( M \).

D8.1 \( M, w_C \models P^n(x) \iff \langle \eta(x_1), ..., \eta(x_n) \rangle \in N_w(P^n) \).

D8.2 \( M, w_C \models x_i = x_j \iff \eta(x_i) = \eta(x_j) \), where \( \eta(x_i), \eta(x_j) \in D(w) \).

D8.3 \( M, w_C \models \phi \& \psi \iff M, w_C \models \phi \) and \( M, w_C \models \psi \).

D8.4 \( M, w_C \models \neg \phi \iff \text{it’s not the case that} \ M, w_C \vdash \phi \).

D8.5 \( M, w_C \models \phi \iff \text{there is some possibility} \ v_C \text{ such that} \langle F, N^{\text{wc}}, \tilde{\eta}, f \rangle, v_C \models \phi \), where \( \eta \overset{C}{\rightarrow} \tilde{\eta} \) and \( N^{\text{wc}} \) is the interpretation of \( N \) at \( w_C \).

D8.6 \( M, w_C \models \exists x \phi(x) \iff \text{there is some} \ \tilde{\eta} \overset{x}{\approx} \eta \text{ such that} \langle F, N, \tilde{\eta}, f \rangle, v_C \models \phi(x) \).

D8.7 \( M, w_C \models \phi \iff \psi \) iff for all possibilities \( v_C \), such that \( f(\phi, w_C) = v_C \), \( \langle F, N^{\text{wc}}, \tilde{\eta}, f \rangle, v_C \models \psi \).
where $\eta \subseteq \tilde{\eta}$ and $N^{w_C}$ is the interpretation of $N$ at $w_C$, and $\|\phi\| \subseteq \text{Pos}(F)$ is the set of all possibilities $u_C$ such that $(F, N^{w_C}, \tilde{\eta}, f), u_C \models \phi$.

B Proofs

Disclaimer: I have just rewritten the previous section, but I have not updated this section to have terminology consistent with it. Consequently most of the following proofs do not make sense; I keep them in this draft so you can see where I am trying to go.

I will now show that the above logic has some desirable properties. If some formula $\psi$ is true at all worlds on a model, we will say that it is true on the model, or $M \models \psi$. If a formula $\phi$ is true on every model, then it is a theorem of the counterpart-theoretic system, or $\models \phi$. We will call such formulas “$C$-valid”.

If $\phi$ is a theorem of predicate logic, then $\models \phi$: suppose $\phi$ is a theorem of predicate logic. Then any formula which results from non-logical constants in $\phi$ with terms of the same type is true (from the definition of a theorem in predicate logic). If $c_v(\phi) = \psi$, then $\psi$ can be obtained from $\phi$ by such substitution (this follows from the definition of a formula counterpart above). Thus if for any $\phi$ and $v \in \beta$, $c_v(\phi) = \psi$ then $\beta \models \psi$. Thus $\models \psi$.

Necessitation: We want to prove that every $C$-valid formula is necessary. Assume that $\phi$ is $C$-valid. Then $\phi$ has a counterpart which is true at every possibility. Then, for each world $w$ there are no possibilities $\beta$ with respect to $w$ such that $\beta \models \neg \psi$, where $\psi = c(\phi)$. Thus there are no worlds where $\diamond \neg \phi$. Thus $\neg \diamond \neg \phi$ is true at all worlds, and so $\Box \phi$ is true at all worlds. So $\models \Box \phi$.

K-axiom: We want to prove that if $\models \Box(\phi \supset \psi)$ then $\models \Box \phi \supset \Box \psi$. Suppose $\models \Box(\phi \supset \psi)$. Then at every world $w$ and possibility $v$ with respect to $w$, there is some $\mu$ and $\nu$ such that $c_v(\phi) = \mu$ and $c_v(\psi) = \nu$, and $\mu \supset \nu$. Now assume $\Box \phi$ (for conditional proof). Then at every possibility where $c_v(\phi) = \mu$, $\mu$ is true. And we have already shown that $\mu \supset \nu$ is true (where $\nu = c_v(\psi)$). So $\nu$ is true at $\beta$. But $\beta$ was chosen arbitrarily, so $\psi$ has a true counterpart at every possibility where has a counterpart. So $\Box \psi$ follows from our assumption of $\Box \phi$. Hence $\models \Box \phi \supset \Box \psi$, which is what we wanted to show.

Single Premise Consequent Closure (Nolan, 1997, p. 551) points out that, on an impossible worlds approach, we cannot infer $\phi \Box \rightarrow \psi$ from $\phi \Box \rightarrow \nu$ and $M, \nu \models \psi$. This inference is valid on the counterpart theoretic model. Suppose $M, \nu \models \psi$. Then $\psi$ has a counterpart at every world $v$ such that $M, v \models \nu$ such that $M, v \models \psi$. Now suppose $\phi \Box \rightarrow \nu$. Then $f(w, \phi) = \nu^{w_C}$, where $v \models \nu$. Hence $v \models \psi$, so $\phi \Box \rightarrow \psi$.}

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Multi-premise consequent closure: (Nolan 1997, p. 551) points out that, on an impossible worlds approach, we cannot infer \( \phi \entails \psi \) from \( \phi \entails v, \phi \entails \mu \) and \( M, v, \mu \models \psi \). This inference is valid on the counterpart theoretic model. Suppose \( M, v, \mu \models \psi \). Then \( \psi \) has a counterpart at every world \( v \) such that \( M, v \models \nu \) such that \( M, v, \mu \models \psi \). This inference is valid on the counterpart theoretic model. Suppose \( M, v, \mu \models \psi \). Then \( \psi \) has a counterpart at every world \( v \) such that \( M, v \models \nu \) such that \( M, v, \mu \models \psi \). This inference is valid on the counterpart theoretic model. Suppose \( M, v, \mu \models \psi \). Then \( \psi \) has a counterpart at every world \( v \) such that \( M, v \models \nu \) such that \( M, v, \mu \models \psi \). This inference is valid on the counterpart theoretic model. Suppose \( M, v, \mu \models \psi \). Then \( \psi \) has a counterpart at every world \( v \) such that \( M, v \models \nu \) such that \( M, v, \mu \models \psi \).

Conditional Proof (Nolan 1997, p. 549) again argues this fails on the impossible worlds approach. We want to show that if \( M, \phi \models \psi \) then \( M \models \phi \entails \psi \). Suppose \( M, \phi \models \psi \). Then every \( \phi \) possibility is a \( \psi \) possibility. Then at each world, the closest \( \phi \) possibility (if it exists) is a \( \psi \) possibility. Hence at each world \( \phi \entails \psi \). Hence \( M \models \phi \entails \psi \).

C Extensions

The present semantics validates the following: \( \Box \neg \phi \entails \phi \entails \psi \) for any \( \psi \). This, of course, is counterpossible triviality, exactly the thing we were trying to avoid. What’s gone wrong? Our definition of \( \diamond \) (D5) used the full range of possibilities provided by our counterpart relation, but, as I argued in §3.1, some counterpart relations provide us with metaphysical impossibilities. To represent this, we can modify D5 in one of two ways, corresponding to the two options for defining metaphysical possibility I alluded to in §3.1: grafting and legislating.

Grafting

The grafting strategy uses the counterpart relation to build impossibilities out of a prior set of metaphysically possible worlds. On this strategy, the worlds represent metaphysical possibilities all by themselves, and counterpart relations are added to the worlds to generate nontrivial counterpossible conditionals. The natural way to modify D5 to represent this is to define possibility in terms of worlds, rather than in terms of possibilities.

\[ D5_G \quad M, w \models \phi \iff \text{there is some world } v \text{ such that } wRv \text{ and } v \models \phi. \]

With \( D5_G \) replacing D5 we can construct a counterexample to \( \Box \neg \phi \models \phi \Box \entails \psi \).

Here’s one: we stipulate that two predicates co-refer at every world, but only one of them has a counterpart at some world. Let’s call the predicates \( W, H \), and \( S \). Because (by stipulation) \( W \) and \( H \) necessarily have the same extension, \( M \models \Box WxWx \equiv Hx \), so \( M \models \neg \Box Wa \& \neg Ha. \) Since \( S \) is a counterpart of \( W \) but not \( H \), we can stipulate that there is some closest world \( w \) with a possibility \( v \) (in our technical sense) where \( M, v \models Sa \& \neg Ha \) and \( Sa \& \neg Ha \) is the counterpart at \( v \) of the formula \( Wa \& \neg Ha \) at \( w \). Since \( Ha \) does not hold in this world (or any other with \( Wa \)), \( M, w \models \Box \neg Wa \& \neg Ha \) but \( M, w \not\models Wa \& \neg Ha \Box \entails Ha. \)
This is a counterexample to the relevant formula, with $\phi = Wa \& \neg Ha$ and $\psi = Ha$.

**Legislatting**

The *legislatting* strategy identifies some subset of the counterpart relations as representing metaphysical possibilities, effectively ruling some possibilities metaphysically possible and others metaphysically impossible. To represent this in our framework we identify a subset of the counterpart relations $C_m \subset C$. We will use the subscript $m$ to mark those counterpart relations $C_m(w, v) \in C_m$, similarly for counterparts $\phi^C_m$, and possibilities $v^\phi C$. Intuitively, the relations in $C$ are those which hold fixed certain actual-world dependence relations or obey the laws of grounding.

$D5_L$, $M, w \vDash \Diamond \phi$ iff there is some possibility $v^\phi C_m$ such that $v \vDash \phi^C_m$.

Since $\Diamond$ is defined using a subset of $C$ and $\Box$ is defined using all of $C$, we will be able to construct counterexamples to $M, \Box \neg \phi \vDash \phi$ along the lines of that for the grafting strategy above (this exercise is left to interested readers).
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